Exam 2. Chapters 5-8

Name

Answer all the questions.

1) Asterix and assign (R) or (S) to all the chiral centers in the following molecules.

(a) \[
\begin{array}{c}
\text{H} \\
\text{HO} \\
\text{Cl} \\
\text{CH}_3
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CH}_2\text{Br} \\
\text{H} \\
\text{Br} \\
\text{H} \\
\text{CH}_2\text{Br}
\end{array}
\]

(c) \[
\begin{array}{c}
\text{H}_3\text{C} \\
\text{NH}_2 \\
\text{O}
\end{array}
\]

2) Also indicate whether each molecule is chiral or achiral. If one of the above molecules is achiral explain in a single sentence why it is achiral.

(a) 

(b) 

(c)
3) True or False? A molecule can be chiral even though it does not contain any chiral atoms.

4) Label the compounds below as either cis or trans, and explain why the two isomers cannot interconvert at room temperature.

\[
\begin{align*}
\text{cis:} & & \text{trans:} \\
\text{H} & \text{CH}_3 & \text{H} & \text{H} \\
\text{H}_3\text{C} & \text{H} & \text{H}_3\text{C} & \text{CH}_3
\end{align*}
\]

5) Name this compound in IUPAC form.

\[
\begin{array}{c}
\text{Br} \\
\text{Br}
\end{array}
\]
6) Draw *cis*-1,2-dichloro-1-methylcyclohexane.

7) For each pair of molecules, circle the one which will ionize (solvolyze) the quickest in a polar solvent, and write a sentence to explain your answer/guess.

(a) Cl

(b) Cl

(c) Br

(d) Br

(e) Cl
8) 1-Bromomethylcyclohexane undergoes both elimination and substitution reactions when heated in ethanol, which generates three products.

(a) Label the individual products as either substitution or elimination products. For any elimination products state which atoms have been eliminated, and what name the elimination is therefore called.

(b) Provide a mechanistic explanation for the formation of these three different products.
9) The optical rotation of plane polarized light of the reactant molecule is +12.1°. What is the optical rotation of the product in this $S_N1$ reaction?

![SN1 reaction](image)

10) Below are two isomers of dibromonorbornane.

(a) Which isomer undergoes reaction with Potassium $t$-Butoxide the fastest?

(b) Which isomer undergoes reaction with Potassium Iodide the fastest?

(c) Write the mechanism and products of the reaction with Potassium Iodide.
11) Write above the arrow the best reagents to use for each of the following transformations.

(a) \[ \text{H} \quad \text{CH}_3 \quad \text{H} \quad \text{CH}_3 \quad \rightarrow \quad \text{H}_3\text{C} \quad \text{H} \quad \text{CH}_3 \quad \text{H} \quad \text{CH}_3 \]

(b) \[ \text{H} \quad \text{CH}_3 \quad \text{H} \quad \text{CH}_3 \quad \rightarrow \quad \text{H}_3\text{C} \quad \text{H} \quad \text{CH}_3 \quad \text{HO} \quad \text{H} \]

(c) Which is the Markovnikov product?
Exam 2. Chapters 5-8  

Name

Answer all the questions.

1) Asterix and assign (R) or (S) to all the chiral centers in the following molecules.

(a)

(b)

(c)

2) Also indicate whether each molecule is chiral or achiral. If one of the above molecules is achiral explain in a single sentence why it is achiral.

(a) Chiral

(b) Achiral. (Meso compound has a plane of symmetry)

(c) Chiral
3) True or False? A molecule can be chiral even though it does not contain any chiral atoms. **TRUE**

4) Label the compounds below as either cis or trans, and explain why the two isomers cannot interconvert at room temperature.

![Chemical structures](image)

They cannot interconvert because of the TT bond. p orbital overlap is lost on rotation.

5) Name this compound in IUPAC form.

![Chemical structure](image) **3-Bromo(3Z,5E) octadiene**
6) Draw cis-1,2-dichloro-1-methycyclohexane.

![Cyclohexane structure](image)

7) For each pair of molecules, circle the one which will ionize (solvolyze) the quickest in a polar solvent, and write a sentence to explain your answer/guess.

(a) \[
\begin{align*}
\text{Cl} & \quad \text{Cl} \\
\end{align*}
\]

(b) \[
\begin{align*}
\text{Cl} & \quad \text{I} \\
\end{align*}
\]

(c) \[
\begin{align*}
\text{Br} & \quad \text{CH}_2\text{Br} \\
\end{align*}
\]

(d) \[
\begin{align*}
\text{Br} & \quad \text{CH}_2\text{Br} \\
\end{align*}
\]

(e) \[
\begin{align*}
\text{Cl} & \quad \text{Cl} \\
\end{align*}
\]

**Explanation:**

3° > 2° (better leaving group)

2° > 1° (allylic > aryl)

allylic > 2°
8) 1-Bromomethylcyclohexane undergoes both elimination and substitution reactions when heated in ethanol, which generates three products.

(a) Label the individual products as either substitution or elimination products. For any elimination products state which atoms have been eliminated, and what name the elimination is therefore called.

(b) Provide a mechanistic explanation for the formation of these three different products.
9) The optical rotation of plane polarized light of the reactant molecule is +12.1°. What is the optical rotation of the product in this \( S_N^1 \) reaction?

\[
\begin{array}{c}
\text{CH}_3 & \text{CH}_3OH \\
\text{H} & \text{H} \\
\text{Br} & \text{Br} \\
\text{Sn}^1 & \\
(+12.1°) & \\
\end{array}
\]

\[\text{ZERO, A RACEMIC PRODUCT IS FORMED}\]

10) Below are two isomers of dibromonorbornane.

(a) Which isomer undergoes reaction with Potassium \(^1\text{Butoxide}\) the fastest?

(b) Which isomer undergoes reaction with Potassium Iodide the fastest?

(c) Write the mechanism and products of the reaction with Potassium Iodide.
11) Write above the arrow the best reagents to use for each of the following transformations.

(a) 
\[ \text{H}_3\text{C} - \text{H} - \text{CH}_3 \xrightarrow{\text{H}_2\text{O}, \text{H}^+} \text{H}_3\text{C} - \text{CH}_3 - \text{CH}_3 \] 
(or \[ \text{H}_2\text{SO}_4, \text{H}_2\text{O} \] 
or \[ \text{AcOH} \text{(Ac)2, H}^+ , \text{NaBH}_4 \])

(b) 
\[ \text{H}_3\text{C} - \text{H} - \text{CH}_3 \xrightarrow{\text{BH}_3\text{THF}} \text{H}_3\text{C} - \text{CH}_3 - \text{CH}_3 \] 
\[ \xrightarrow{\text{H}_2\text{O}_2, \text{OH}} \]

(c) Which is the Markovnikov product? 
\[ (a) \]