<table>
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<th>QUESTION</th>
<th>POINTS</th>
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1. Assign an (R) or (S) configuration to the stereocenter in norepinephrine (3 points).

\[
\begin{array}{c}
\text{HO} \\
\text{HO} \\
\text{C} \\
\text{OH} \\
\text{CH}_2\text{NH}_2
\end{array}
\]

2. Answer the following questions about tartaric acid.

\[
\begin{array}{c}
\text{COOH} \\
\text{OH} \\
\text{H} \\
\text{OH} \\
\text{COOH}
\end{array}
\]

a.) What is (R)/(S) designation of the indicated stereocenter? (3 points)

b.) Is this stereoisomer of tartaric acid optically active? Why or why not? (3 points)

3. a.) Place an asterisk at all stereogenic centers in guaiol (3 points).

\[
\begin{array}{c}
\text{H}_3\text{C} \\
\text{H}_3\text{C} \\
\text{C} \\
\text{CH}_3 \\
\text{CH}_3
\end{array}
\]

b.) How many stereoisomers are possible for guaiol? Show how you arrived at this conclusion (2 points).

4. Identify the relationship between the following pairs of molecules by describing them as enantiomers, diastereomers, constitutional isomers, or two molecules of the same compound. (15 points)

a.) b.) c.)

\[
\begin{array}{c}
\text{HO} \\
\text{COOH} \\
\text{CH}_3 \\
\text{H}
\end{array}
\]

\[
\begin{array}{c}
\text{CH}_3 \\
\text{OH} \\
\text{H}
\end{array}
\]

\[
\begin{array}{c}
\text{H} \\
\text{Cl} \\
\text{Cl}
\end{array}
\]

\[
\begin{array}{c}
\text{CH}_3 \\
\text{H}
\end{array}
\]

d.) e.)

\[
\begin{array}{c}
\text{CH}_3 \\
\text{H}
\end{array}
\]

\[
\begin{array}{c}
\text{CH}_3 \\
\text{H}
\end{array}
\]

\[
\begin{array}{c}
\text{CH}_3 \\
\text{H}
\end{array}
\]

5. Provide an IUPAC name for the following molecule (4 points).

\[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \\
\text{Br} \quad \text{H}_3\text{C}
\end{array}
\]

6. What is a Grignard reagent? Give an example (4 points).
7. Match each of the following definitions to a term from the list below. Place the letter of the term in the blank to the left of the definition (12 points).

- A. Racemic Mixture
- B. Enantiomers
- C. Stereogenic Center
- D. Resolution
- E. Diastereomers
- F. Meso Compounds

_______ Stereoisomers that are non-superimposable mirror images.
_______ The process of separating a racemic mixture into pure enantiomers.
_______ Molecules which contain stereogenic centers but are achiral.
_______ A 50:50 mixture of enantiomers.
_______ Stereoisomers that are not mirror images.
_______ An atom connected to 4 different groups.

8. Provide reagents which will carry-out the following transformations (12 points).

a.)
\[
\begin{array}{c}
\text{CH}_3\text{C-CH}_3 \\
\text{HO-CH}_3
\end{array} \xrightarrow{\text{?}} \begin{array}{c}
\text{CH}_3\text{C-CH}_3 \\
\text{Br-CH}_3
\end{array}
\]

b.)
\[
\begin{array}{c}
\text{CH}_3\text{C-CH}_3 \\
\text{HO-CH}_3
\end{array} \xrightarrow{\text{?}} \begin{array}{c}
\text{CH}_3\text{C-CH}_3 \\
\text{Br-CH}_3
\end{array}
\]

c.)
\[
\begin{array}{c}
\text{CH}_3\text{Li}
\end{array} \xrightarrow{\text{?}} \begin{array}{c}
\text{(CH}_3)_2\text{CuLi}
\end{array} \xrightarrow{\text{?}} \begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3
\end{array}
\]

9. Which product (or products) would you expect to obtain from each of the following reactions? In each case, give the mechanism (S\text{N}_1, S\text{N}_2, E1, E2) by which each product is formed and predict the relative amount of each (i.e. the only product, the major product, a minor product etc.?!) (12 points)

a.)
\[
\text{Br-CH} = \text{CH}_3 \xrightarrow{\text{CH}_3\text{CH}_2\text{O-}^{\text{Na}^+}} \text{CH}_3\text{CH}_2\text{O-}^{\text{Na}^+} \xrightarrow{\text{DMSO}}
\]

b.)
\[
\text{H}_3\text{C-Br} \xrightarrow{\text{CH}_3\text{OH} \atop 25^\circ\text{C}}
\]
10. Draw all resonance structures for each of the following (9 points).

a.)

b.)

11. Consider the following reaction.

\[
\text{CH}_3\text{CH}_2\text{CH}_2\text{I} \xrightarrow{\text{NaOH}} \text{CH}_3\text{CH}_2\text{CH}_2\text{OH}
\]

\[
\text{dimethylsulfoxide (DMSO)}
\]

a.) What affect would you expect on the rate of the reaction if the concentration of sodium hydroxide is doubled? Explain (3 points).

b.) What affect would you expect on the rate of the reaction if the solvent was changed from DMSO (dimethylsulfoxide) to water? Explain (3 points).

12. Consider the following reaction.

\[
\text{CH}_3\text{C} - \text{CH}_3 \xrightarrow{\text{H}_2\text{O}} \text{CH}_3\text{C} - \text{CH}_3
\]

a.) What affect would you expect on the rate of the reaction if leaving group was changed to iodide? Explain (3 points).

b.) What affect would you expect on the rate of the reaction if the concentration of water is tripled? Explain (3 points).

13. a.) Which substrate will react faster in an S\text{N}_2 reaction with hydroxide (3 points)?

\[
\text{CH}_3\text{I} \quad \text{or} \quad (\text{CH}_3)_3\text{Cl}
\]

a.) Which substrate will react faster in an S\text{N}_1 reaction with methanol (CH\text{}_3\text{OH}) (3 points)?

\[
\text{CH}_3\text{F} \quad \text{or} \quad \text{CH}_3\text{CHBrCH}_3
\]