Answer Key

Answer all 19 questions (150 pts).

*1. (12) Designate either R or S to each of the following molecules. You must show the priorities (#1 = highest) of all 4 attached groups (in each case) to receive full credit.

   a) 
   b) 

*2. (7) Write a step-by-step synthesis of the product shown using acetylene and any necessary organic or inorganic reagents.

*3. (5) In each of the following examples, state whether, overall, the reaction is a Markovnikov or anti-Markovnikov addition.

   a)  
   b)  

*4. (10) Fill in the missing blanks. A molecule with 3 chiral centers (and one stereoisomer that is meso) has 7 (give a number) stereoisomers. If we examine the RRR stereoisomer, its enantiomer will be the ___SSS___ stereoisomer? The relationship between the RRR stereoisomer and the SSR stereoisomer is that they are diastereomers? If the SSR stereoisomer has an optical rotation of -47° then the RRS stereoisomer would have an optical rotation of ___+47°___?
5. (5) In each of the following examples, state whether the reaction is a syn or anti addition.

a) ![Reaction diagram](attachment:reaction_a.png)
   SYN

b) ![Reaction diagram](attachment:reaction_b.png)
   SYN

6. (7) Ephedrine is a potent dilator of air passages in the lungs. How many stereoisomers are possible for ephedrine? In addition, the pharmacologically active form of ephedrine is shown below on the right. Label the chiral centers as (R) or (S).

   ![Ephedrine](attachment:ephedrine.png)

   \[2^2 = 4\] stereoisomers

7. (9) Show curved arrows to indicate the first step of a reaction between each of the following partners. You need not show products.

a) ![Reaction diagram](attachment:reaction_a.png)

b) ![Reaction diagram](attachment:reaction_b.png)

8. (31) In each of the following reactions reactants or products are missing. Fill in the blanks with the appropriate molecules. If more than one step is involved, indicate this by using 1)......; 2)........ If more than one product could be formed, show only the major product(s). Where appropriate, draw the stereochemistry of the product(s).

a) ![Reaction diagram](attachment:reaction_a.png)

b) ![Reaction diagram](attachment:reaction_b.png)
b)\[\begin{array}{c}
\begin{array}{c}
\text{HCl (2 equiv.)} \\
\text{or } R_2BH \text{ then } H
\end{array}
\end{array}\]

\[\text{Li, NH}_3\]

1) Li, NH$_3$
2) H$_2$O

\[\begin{array}{c}
\begin{array}{c}
\text{H}_2\text{O}_2, \text{HO}^-
\end{array}
\end{array}\]

\[\begin{array}{c}
\begin{array}{c}
\text{HgSO}_4, \text{H}_3\text{O}^+
\end{array}
\end{array}\]

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

\[\begin{array}{c}
\begin{array}{c}
\text{Acetone}
\end{array}
\end{array}\]

c)\[\begin{array}{c}
\begin{array}{c}
\text{NBS, light}
\end{array}
\end{array}\]

\[\begin{array}{c}
\begin{array}{c}
\text{Br}
\end{array}
\end{array}\]

\[\begin{array}{c}
\begin{array}{c}
\text{Br}
\end{array}
\end{array}\]

d)\[\begin{array}{c}
\begin{array}{c}
\text{OH}
\end{array}
\end{array}\]

\[\begin{array}{c}
\begin{array}{c}
\text{HBr}
\end{array}
\end{array}\]

\[\text{Br}\]

\[\begin{array}{c}
\begin{array}{c}
\text{Br}
\end{array}
\end{array}\]

*9. (6) For each pair indicated below, indicate by yes or no whether or not they represent resonance forms.

a)\[\begin{array}{c}
\begin{array}{c}
\text{O}^-
\end{array}
\end{array}\]

\[\begin{array}{c}
\begin{array}{c}
\text{O}^+
\end{array}
\end{array}\]

• Yes
• No

b)\[\begin{array}{c}
\begin{array}{c}
\text{+}
\end{array}
\end{array}\]

\[\begin{array}{c}
\begin{array}{c}
\text{+}
\end{array}
\end{array}\]

• Yes
• No

*10. (18) For each of the following pairs, circle all of the statements to their right which are correct.

a)\[\begin{array}{c}
\begin{array}{c}
\text{HO} \text{and COOH}
\end{array}
\end{array}\]

• constitutional
• enantiomers
• identical
• meso
• stereoisomers
• diastereomers
b) • mirror images • enantiomers • identical • meso • stereoisomers • diastereomers

H₃C \[CH₂ClH \]

and

H \[CH₂ClH \]

• mirror images • enantiomers • identical • meso • stereoisomers • diastereomers

H₃CH₂C \[CH₃ \]

and

H₂N \[CH₃ \]

• mirror images • enantiomers • identical • meso • stereoisomers • diastereomers

**11. (10)** Circle any of the following which are chiral.

a) b) c) d) CHO

**12. (6)** In principle, how many different, mono-chloro products could be formed from the reaction shown below? In addition, draw one of these mono-chloro products.

**13. (3.5)** True or False? One of the stereoisomers of 2,4-dibromopentane is achiral.

**14. (3)** True or False? Since the pKa of a terminal alkyne H is ~25, any base which is the conjugate base of an acid of pKa >25 will be able to abstract such a proton.

**15. (3)** True or False? R-(+)-Limonene is found in oranges. Its enantiomer, found in lemons, must be S-(−)-Limonene.
*16. (2.5) True or False? \( \text{H}_2 \) and Lindlar's catalyst will react with a \( \text{cis} \)-alkene.

*17. (3) True or False? A \( \text{C}≡\text{C} \) is collectively stronger than a \( \text{C}═\text{C} \).

*18. (5) Circle any of the answers in the box below that could be correct for a molecule that shows no optical rotation.

- achiral
- enantiomer
- a racemate
- meso
- chiral

*19. (4) Draw the conjugate base of 3-methyl-1-pentyne.