Answer Key

Answer all 16 questions (150 pts).

1. (14) 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) Place asterisks (*) at all the chiral centers in the molecule shown. How many stereoisomers are possible? Could any of these stereoisomers be meso?

   
   # stereoisomers: $2^3 = 8$
   None can be meso - no symmetry

3. (8) For a chiral compound (A), with 5 chiral centers, typically there will be $32$ (a #) stereoisomers possible, unless one of these is a **meso** compound, where there are $2^n - 1$ stereoisomers. A stereoisomer differing at only 4 chiral centers from compound (A) would be a(n) **diastereoisomer** of (A). If a stereoisomer differed from (A) at all 5 chiral centers, this species would be a(n) **enantiomer** of (A).

4. (3) Which of the following molecules is chiral?
   a) 1-chloroheptane
   b) 2-chlorohexane
   c) 1,5-dichloropentane
   d) 2,2-dichlorohexane

5. (12.5) From the list below, state whether each species shown is an electrophile or nucleophile.

   a) HgSO₄  b) NaBH₄  c) HI  d) BF₃  e) LiN₃
   electrophile  nucleophile  electrophile  electrophile  nucleophile

6. (2.5) True or False? A molecule with a non-superimposable mirror image must be chiral.

7. (2.5) True or False? A hydrogen attached to a carbon of a triple bond can be abstracted using a base, the conjugate acid of which is stronger than the alkyne.
8. (6) In the following reaction, i) how many different mono-chloro products could be obtained? ii) Why would this compound not react with NBS / light?

\[
\begin{align*}
\text{Cl}_2 & \xrightarrow{\text{light}} \quad \text{i) Four} \\
\text{NBS substitutes a Br for an H at an allylic position. The molecule shown has no C=C, so there is no allylic position.}
\end{align*}
\]

9. (7) Write a synthesis of the product shown using acetylene and any necessary organic or inorganic reagents.

\[
\begin{align*}
\text{HC≡C} & \text{ Na}^+ \\
\text{Br} & \quad \text{HgSO}_4 \quad \text{H}_3\text{O}^+
\end{align*}
\]

10. (5) Transform the following into another satisfactory Fischer projection retaining the same configuration (i.e. R remains R, S remains S).

\[
\begin{align*}
\text{Cl} & \quad \text{Cl} \\
\text{H}_2\text{N} & \quad \text{Cl} \quad \text{NH}_2 \\
\text{H} & \quad \text{H} \\
\text{OH} & \quad \text{OH} \quad \text{H}
\end{align*}
\]

11. (9) In total, how many stereoisomers are there for each of the following?

\[
\begin{align*}
\text{achiral} & \quad \text{b) 4} \\
\text{0} & \quad \text{c) 8}
\end{align*}
\]
12. (7.5) For the following questions match each definition to a term from the list below.

A. racemate  B. chiral center  C. chiral molecules  
D. diastereomers  E. enantiomers  F. meso compounds

a) _____ A _____ is a 50 : 50 mixture of both enantiomers.

b) _____ D _____ are stereoisomers which are not mirror images.

c) _____ C or E _____ are molecules which contain chiral centers and have no plane of symmetry.

13. (36) 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)  

\[
\begin{align*}
\text{H}_2 & \xrightarrow{\text{Lindlar's catalyst}} \text{R}_2\text{BH}, \text{R}= \text{bulky alkyl} \\
& \xrightarrow{2) \text{H}_2\text{O}_2, \text{OH}^-} \\
& \xrightarrow{1) \text{NaNH}_2} \xrightarrow{2) \text{EtI}} \\
\end{align*}
\]

b) 

\[
\begin{align*}
\text{OH} & \xrightarrow{\text{HBr}} \\
& \xrightarrow{3 \text{ alcohol}} \\
\end{align*}
\]

c)  

\[
\begin{align*}
1) \text{Cl}_2 \text{ or Br}_2 \text{ (1 equiv.)} & \xrightarrow{2) \text{Br}_2 \text{ or Cl}_2} \\
\end{align*}
\]

d)  

\[
\begin{align*}
\text{H}_2 / \text{Lindlar's catalyst} & \xrightarrow{\text{or: Li / NH}_3 \text{ then H}_2\text{O}} \\
\end{align*}
\]
14. (9) For each pair indicated below, indicate by yes or no whether or not they represent resonance forms.

a)  

- Yes  
- No

b)  

- Yes  
- No

c)  

- Yes  
- No

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

a)  

- constitutional isomers  
- enantiomers  
- identical  
- meso  
- stereoisomers  
- diastereomers

b)  

- mirror images  
- enantiomers  
- identical  
- meso  
- stereoisomers  
- diastereomers

c)  

- mirror images  
- enantiomers  
- identical  
- meso  
- stereoisomers  
- diastereomers

16. (3) If a molecule has 50 chiral centers and 5 of the possible stereoisomers are meso, there will be how many stereoisomers in total?

a) $2^5 - 50$  
b) $5^{50} - 2$  
c) $2^{50-5}$  
d) $2^{50} - 5$