1-10 are True / False (10pts)

1) An object is *chiral* if it is different from its mirror image.

2) Alkyl groups are good leaving groups for elimination and substitution reactions.

3) E2 reactions are stereospecific because they strongly prefer the anti-coplanar alignment of proton and leaving group.

4) *S*_1 and E1 reactions always involve a carbocation intermediate.

5) An *elimination* is a reaction where two atoms or groups are removed to produce a new π bond.

6) Hammond’s postulate implies that a higher yield of an elimination product will be produced by stirring in a clockwise direction.

7) These molecules are the same enantiomer.

8) An *addition* is a reaction where a nucleophilic species replaces another group or atom in a molecule.

9) π bonds are weaker than σ bonds.

10) π bonds are formed by the sideways overlap of aligned p orbitals on adjacent atoms.
11) For each threesome, circle the more stable species. (3pts)

(a) 

(b) 

(c) 

12) Assign $E$ or $Z$ to each double bond below (do not fully IUPAC name them!) (2pts)

(a) 

(b) 

13) The $S_N2$ reaction is the most famous stereospecific reaction. (1+2pts)
a) In one sentence state the type of stereospecificity that the $S_N2$ reaction displays.

b) Briefly describe the geometric requirement that causes this stereospecificity.
14) Assign R or S to every chiral center in these molecules. (6pts)

(a) \[
\begin{array}{c}
\text{CO}_2\text{H} \\
\text{H}_3\text{C} - \text{C} - \text{OH}
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CO}_2\text{H} \\
\text{HO} - \text{H} \\
\text{CH}_3
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CH}_2\text{OH} \\
\text{CH}_2\text{OH}
\end{array}
\]

15) Name these compounds in IUPAC form. (2+3+3=8pts)

(a) \[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{I}
\end{array}
\]

(b) \[
\begin{array}{c}
\text{H} - \text{C} = \text{C} - \text{CH}_3\text{CH}_2\text{F} \\
\text{CH}_3\text{CH}_2\text{H}
\end{array}
\]

(c) \[
\begin{array}{c}
\text{Cl} \\
\text{Cl}
\end{array}
\]
16) Draw in the curly arrows to complete this electrophilic addition mechanism. (3pts)

\[ \text{Ocycles} \rightarrow \text{H\text{\textsuperscript{+}}} \rightarrow \text{SO\text{\textsuperscript{2}-}} \]

17) Write a mechanism (i.e. curly arrows) for this E1 elimination. (3pts)

[Diagram of E1 elimination reaction]
18) Draw the products formed in the following transformations of the below cyclic alkene, *paying attention to stereo- and regio-chemistry where relevant.* (6x2=12pts)

**Bonus Question for up to 2 points.**

The molecule in Question 14b is in fact the naturally occurring enantiomeric form of lactic acid produced in humans. What is the biochemical connection between that compound, and the molecules in parts 14a and 14c?
Fall 2015: Exam 2  Chapters 5-8  50 points

Name: BAKER

If you DO NOT want your graded exam placed in the box outside my office, then please mark a cross here.

1-10 are True / False (10pts)

1) An object is *chiral* if it is different from its mirror image.  

2) Alkyl groups are good leaving groups for elimination and substitution reactions.

3) E2 reactions are stereospecific because they strongly prefer the anti-coplanar alignment of proton and leaving group.

4) S_N1 and E1 reactions always involve a carbocation intermediate.

5) An *elimination* is a reaction where two atoms or groups are removed to produce a new \( \pi \) bond.

6) Hammond’s postulate implies that a higher yield of an elimination product will be produced by stirring in a clockwise direction.

7) These molecules are the same enantiomer.

8) An *addition* is a reaction where a nucleophilic species replaces another group or atom in a molecule.

9) \( \pi \) bonds are weaker than \( \sigma \) bonds.

10) \( \pi \) bonds are formed by the sideways overlap of aligned p orbitals on adjacent atoms.
11) For each threesome, circle the more stable species. (3pts)

(a) 

(b) 

(c) 

12) Assign E or Z to each double bond below (do not fully IUPAC name them!) (2pts)

(a) 

(b) 

13) The $S_N2$ reaction is the most famous stereospecific reaction. (1+2pts)
   a) In one sentence state the type of stereospecificity that the $S_N2$ reaction displays.
   
   \[ \text{Gives 100\% inversion of stereochemistry} \]

   b) Briefly describe the geometric requirement that causes this stereospecificity.

   \[ \text{The concerted } S_N2 \text{ mechanism requires the nucleophile to attack directly behind the carbon-leaving group bond. This "back-side attack" pushes the other 3 bonds over causing the inversion of stereochemistry.} \]
14) Assign R or S to every chiral center in these molecules. (6pts)

(a)  
\[
\text{CO}_2\text{H} \quad \text{H}_3\text{C} \quad \text{OH}
\]
\[
\begin{array}{c}
\text{H} \\
\text{3} \\
\text{4}
\end{array}
\]
\[
\begin{array}{c}
\text{C} \\
\text{1}
\end{array}
\]
\[
\begin{array}{c}
\text{2}
\end{array}
\]
\[
\quad = \quad \text{S}
\]

(b)  
\[
\text{CO}_2\text{H} \quad \text{HO} \quad \text{CH}_3
\]
\[
\begin{array}{c}
\text{2} \\
\text{3}
\end{array}
\]
\[
\begin{array}{c}
\text{4}
\end{array}
\]
\[
\quad = \quad \text{S}
\]

(c)  
\[
\text{O} \quad \text{OH}
\]
\[
\begin{array}{c}
\text{3} \\
\text{2}
\end{array}
\]
\[
\begin{array}{c}
\text{1} \\
\text{4}
\end{array}
\]
\[
\quad = \quad \text{S}
\]

15) Name these compounds in IUPAC form. (2+3+3=8pts)

(a)  
\[
\begin{array}{c}
\text{I}
\end{array}
\]
\[
\quad = \quad \text{1-iodoheptane}
\]

(b)  
\[
\text{H} \quad \text{H} \quad \text{CH}_2\text{CH}_2\text{F}
\]
\[
\begin{array}{c}
\text{2} \\
\text{1}
\end{array}
\]
\[
\begin{array}{c}
\text{3}
\end{array}
\]
\[
\text{CH}_3\text{CH}_2
\]
\[
\quad = \quad \text{(E)-1-fluorohex-3-ene}
\]

(c)  
\[
\text{Cl} \quad \text{Cl}
\]
\[
\begin{array}{c}
\text{3} \\
\text{2}
\end{array}
\]
\[
\begin{array}{c}
\text{4}
\end{array}
\]
\[
\quad = \quad \text{cis-1,3-dichlorocyclobutane}
\]
16) Draw in the **curly arrows** to complete this electrophilic addition mechanism. (3pts)

17) Write a mechanism (i.e. curly arrows) for this **E1** elimination. (3pts)
18) Draw the products formed in the following transformations of the below cyclic alkene, paying attention to stereo- and regio-chemistry where relevant. (6x2=12pts)

**Bonus Question** for up to 2 points.

The molecule in Question 14b is in fact the naturally occurring enantiomeric form of lactic acid produced in humans. What is the biochemical connection between that compound, and the molecules in parts 14a and 14c?

*All three are the exact molecule (just drawn using 3 different formats).*