1) An object is chiral if it has a non-superimposable mirror image.

2) This molecule has more than two chiral centers.

3) S$_{N}$2 reactions are stereospecific because the nucleophile must attack from directly behind the Carbon – Leaving Group bond.

4) S$_{N}$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 $\pi$ bond.

6) Hydroxide ion is a poor leaving group in nucleophilic substitutions.

7) These compounds are the same.

8) A nucleophilic substitution is a reaction where a nucleophilic species replaces another group or atom in a molecule.

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

10) $\pi$ bonded electrons are on average further away from the nuclei than electrons in a $\sigma$ bond.

11) S$_{N}$1 reactions always proceed with total loss of stereochemistry.
12) Saytzeff’s rule states that the major product from an elimination will be the more highly alkyl substituted π bond.

13) The inventors of the convention for assigning priority are Chan, Ingerland and Plasmarifle.

14) A diastereomer is a stereoisomer which is not an enantiomer.

15) π bonds can behave as nucleophiles.

16) Assign R or S to each chiral center in these molecules. (8pts)

(a) 
\[
\text{Cl} \quad \text{OH} \\
\text{F} \quad \text{CH}_3
\]

(b) 
\[
\text{CO}_2\text{H} \quad \text{Br} \\
\text{H} \quad \text{Cl} \\
\text{CF}_3
\]

(c) 
\[
\text{HO} \\
\text{HO} \\
\text{H} \\
\text{HOCH}_2 \\
\text{CH}_2
\]

(d) 
\[
\text{HOCH}_2 \\
\text{CH}_2\text{Br} \\
\text{H}
\]

17) What is the name of the type of Projection used in part (b)? (2pts)

18) What is the name of the type of Projection used in part (d)? (2pts)
19) Name these compounds IUPAC form. (9pts)

(a) \[
\text{Br} \quad \square \\
\quad \text{Cl}
\]

(b) \[
\text{CH}_2\text{CH}_2 \quad \text{CH}_2\text{CH}_2\text{F} \\
\quad \text{H} \\
\quad \text{H}
\]

(c) \[
\text{C}_7\text{H}_{15} \quad \text{Cl}
\]

20) For each pair, circle the more stable species. (12pts)

(a) \[
\text{C}_7\text{H}_{15}^+ \\
\text{C}_7\text{H}_{15}^+_+
\]

(b) \[
+ \quad \text{C}_7\text{H}_{15}^+ \\
\quad +
\]

(c) \[
\text{Br}^- \\
\text{F}^-
\]

(d) \[
\text{C}_2\text{H}_4 \quad \text{C}_2\text{H}_4^* \\
\cdot \\
\cdot
\]

(e) \[
\text{H}^+ \\
\cdot
\]

(f) Justify in a sentence or two, your answer to part (e)
21 a) Write a mechanism (i.e. curly arrows) for this E1 elimination. (6+2+2pts)

\[ \text{Br} \xrightarrow{\text{K}^+\text{OCH}_3, \text{CH}_3\text{OH}} \]

b) If three times as much base was added, what would happen to the rate of this reaction?

c) what would happen to the rate if a much less polar solvent was used instead of Methanol?
22) Give the products formed in the following transformations of the below cyclic alkene, *paying attention to stereo- and regio-chemistry where relevant.* (18 + 2 + 2 pts)

![Chemical Structure Diagram]

(i) How many of these 6 transformations give "anti Markovnikov" products?

(ii) What class of compound does the product from the peroxycacid/alkene reaction form?
23) Write the mechanism for either of the ANTI additions reactions in Question 22. (10pts)

24) State the Hammond Postulate. (3pts)

25) What is a meso compound? (3pts)

26) Is this compound chiral? (2pts)

```
CH₃
|   |
H---Br
|   |
Br---H
|   |
CH₃
```

27) Is the above compound the meso or a (dl) diastereomer? (2pts)
**Bonus Question** for up to 3 points.

Using curly arrows (no words), write the mechanism for this transformation.

\[
\begin{array}{c}
\text{OH} \\
\text{Heat} \\
\text{conc. } \text{H}_2\text{SO}_4 \\
\end{array}
\xrightarrow{} 
\begin{array}{c}
\text{alkene} \\
\text{+ H}_2\text{O}
\end{array}
\]
1-15 are True / False (15pts)

1) An object is chiral if it has a non-superimposable mirror image.  
   \[ \text{T} \]

2) This molecule has more than two chiral centers.  
   \[ \text{F} \]

3) $S_N2$ reactions are stereospecific because the nucleophile must attack from directly behind the Carbon – Leaving Group bond.  
   \[ \text{T} \]

4) $S_N1$ and E1 reactions always involve a carbocation intermediate.  
   \[ \text{T} \]

5) An elimination is a reaction where two atoms or groups are removed to produce a new $\pi$ bond.  
   \[ \text{T} \]

6) Hydroxide ion is a poor leaving group in nucleophilic substitutions.  
   \[ \text{T} \]

7) These compounds are the same.  
   \[ \text{T} \]

8) A nucleophilic substitution is a reaction where a nucleophilic species replaces another group or atom in a molecule.  
   \[ \text{T} \]

9) $\pi$ bonds are weaker than $\sigma$ bonds.  
   \[ \text{T} \]

10) $\pi$ bonded electrons are on average further away from the nuclei than electrons in a $\sigma$ bond.  
    \[ \text{T} \]

11) $S_{N1}$ reactions always proceed with total loss of stereochemistry.  
    \[ \text{T} \]
12) Saytzeff's rule states that the major product from an elimination will be the more highly alkyl substituted π bond.

13) The inventors of the convention for assigning priority are Chan, Ingerland and Plasmarifie.

14) A diastereomer is a stereoisomer which is not an enantiomer.

15) π bonds can behave as nucleophiles.

16) Assign R or S to each chiral center in these molecules. (8pts)

(a) [Diagram of a molecule with labels 1 to 4]
   
   \[ \text{Assign R or S: } ] 
   \[ \Rightarrow \text{ S = R} \]

(b) [Diagram of a molecule with labels 1 to 4]
   
   \[ \text{Assign R or S: } ] 
   \[ \Rightarrow \text{ S = R} \]

(c) [Diagram of a molecule with labels 1 to 4]
   
   \[ \text{Assign R or S: } ] 
   \[ \Rightarrow \text{ S = R} \]

(d) [Diagram of a molecule with labels 1 to 4]
   
   \[ \text{Assign R or S: } ] 
   \[ \Rightarrow \text{ S = R} \]

17) What is the name of the type of Projection used in part (b)? (2pts)  
   
   - Fisher

18) What is the name of the type of Projection used in part (d)? (2pts)  
   
   - Newman
19) Name these compounds IUPAC form. (9pts)

(a) \[ \text{Anti-1-bromo-3-chlorocyclohexane} \]

(b) \[ \text{Z-1-fluoro-3-hexene} \]
\[ \text{(1-fluoro-3Z-hexene)} \]

(c) \[ \text{1-chlorohexane} \]

20) For each pair, circle the more stable species. (12pts)

(a) \[ \text{ } \circled{ \text{hexyl cation} } \]

(b) \[ \text{ } \circled{ \text{hexyl cation} } \]

(c) \[ \text{Br}^- \]
\[ F^- \]

(d) \[ \text{ } \circled{ \text{alkene} } \]
\[ \text{ } \circled{ \text{alkene} } \]

(e) \[ \text{ } \circled{ \text{alkyl cation} } \]

(f) Justify in a sentence or two, your answer to part (e).

A carbon radical is surrounded by 7 valence electrons, and a carbocation is surrounded by 6. 7 is closer to the ideal number of 8 valence electrons, so the radical is more stable than the cation.

Fall08org1exam2
21 a) Write a mechanism (i.e. curly arrows) for this E1 elimination. 
(6+2+2pts)

\[
\begin{align*}
\text{Br} & \quad \text{K}^+\text{OCH}_3, \text{CH}_3\text{OH} \\
\downarrow & \quad \text{not shown} \\
\text{not shown} & \quad \text{not shown}
\end{align*}
\]

b) If three times as much base was added, what would happen to the rate of this reaction? 
\text{Not Change}

c) what would happen to the rate if much less polar solvent was used instead of Methanol?
\text{Rate Decrease}
22) Give the products formed in the following transformations of the below cyclic alkene, paying attention to stereo- and regio-chemistry where relevant. (18 + 2 + 2 pts)

(i) How many of these 6 transformations give "anti Markovnikov" products?

ONE

(ii) What class of compound does the product from the peroxyacid/alkene reaction form?

EPoxide
23) Write the mechanism for either of the ANTI additions reactions in Question 22. (10pts)

24) State the Hammond Postulate. (3pts)
   For related processes, species that are similar in energy will be similar in structure.

25) What is a meso compound? (3pts)
   A meso compound is an achiral molecule which contains chiral centers.

26) Is this compound chiral? (2pts)

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

27) Is the above compound the meso or a (dl) diastereomer? (2pts)
**Bonus Question** for up to 3 points.

Using curly arrows (no words), write the mechanism for this transformation.