1-10 Are True/False (10pts)

1) $S_{N1}$ and $E1$ reactions are both types of substitution reaction.

2) $\pi$ bonds are weaker than $\sigma$ bonds, and so it is the $\pi$ bond of a double bond that reacts as the nucleophile.

3) A typical $C=C$ bond length is around 1.3 Angstroms.

4) $I^-$ is a stronger nucleophile than $F^-$. 

5) A stereospecific reaction is where a certain stereoisomer reacts to generate one specific stereoisomer as product.

6) Hex-2-ene and cyclohexane are diastereomers.

7) A Lewis base that donates its two electrons to a (protic) Hydrogen is acting as a base.

8) An epoxide is a 3 membered ring.

9) $S_{N1}$ and $E1$ reactions both proceed through carbocation intermediates.

10) Increasing the steric hindrance around the reaction center will increase the rate of $S_{N2}$ reactions.
11) Provide the correct full IUPAC names for the following molecules. (3+3=6pts)

(a) 

(b) 

12) i) Assign R or S to each chiral center in this Fischer projection. (4pts)

\[ \text{CO}_2\text{H} \]
\[ \text{H} \quad \text{Br} \quad \text{H} \quad \text{Cl} \]
\[ \text{CH}_2\text{OH} \]

ii) Assign R or S to chiral centers A and B in this stick figure (line angle) diagram. (4pts)

A

B

OH

OH

OH

OH

OH

OH
13) Write the mechanism (i.e. curly arrows) for the below electrophilic addition. (3pts)

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{CH}_3 \\
\text{H} & \quad \text{CH}_3 \\
\end{align*}
\xrightarrow{\text{H-F}}
\begin{align*}
\text{H}_3\text{C} & \quad \text{CH}_3 \\
\text{H} & \quad \text{CH}_3 \\
\end{align*}
\]

14) (4pts) The following alkyl bromide will undergo S_N1 reaction with water, as shown below.

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} & \quad \text{H}_2\text{O} \\
\text{Br} & \quad \text{OH} \\
\end{align*}
\xrightarrow{\text{H-Br}}
\]

Write the mechanism (i.e. curly arrows) for this S_N1 process.
15) Provide the **reagents** for the first three, and **products** for the last three transformations. (12pts)

(a) \[ \text{Hg(OAc)}_2, \text{H}_2\text{O} \text{ then NaBH}_4 \]

(b) \[ \text{H-Br, Peroxides (free radical initiator)} \]

(c) \[ \text{OsO}_4, \text{H}_2\text{O}_2 \]

(d) \[ \text{Hg(OAc)}_2, \text{H}_2\text{O} \text{ then NaBH}_4 \]

(e) \[ \text{H-Br, Peroxides (free radical initiator)} \]
16) (7pts) For the molecules below:

![Molecules A, B, and C](image)

a) Are A and B isomers?

b) Indicate whether A or B is more stable.

c) How many \( \pi \) bonds are in C?

d) For the transformation of A (and/or B) into C, what two atoms are removed?

e) What is the preferred geometric relationship between proton and leaving group for an E2 elimination?

f) Under E2 elimination conditions, the production of C from either A or B differs in speed (reaction rate) by a factor of about 500 times. Which is faster, \( A \rightarrow C \) or \( B \rightarrow C \)?

g) Briefly explain your answer to part (f).
**up to 2 BONUS POINTS**

The compound in question (12) part ii is "Xylitol", which is used as an artificial sweetener for drugs, toothpaste, confections and chewing gum.

\[
\text{HO-}
\begin{array}{c}
\text{OH} \\
\text{OH} \\
\text{OH} \\
\text{OH}
\end{array}
\]

Is Xylitol correctly described as a meso compound?

Based on your knowledge of the relationship between chirality and optical activity (rotation of plane polarized light), guess the optical rotation value (including + or - sign, and numerical value) for a 0.1M solution of Xylitol at room temperature.
If you do NOT want your graded exam placed in the box outside my office, then please check here

1-10 Are True/False (10pts)

1) $S_N^1$ and $E_1$ reactions are both types of substitution reaction. \( \text{False} \)

2) $\pi$ bonds are weaker than $\sigma$ bonds, and so it is the $\pi$ bond of a double bond that reacts as the nucleophile. \( T \)

3) A typical $C=C$ bond length is around 1.3 Angstroms. \( T \)

4) $I^-$ is a stronger nucleophile than $F^-$. \( T \)

5) A stereospecific reaction is where a certain stereoisomer reacts to generate one specific stereoisomer as product. \( T \)

6) Hex-2-ene and cyclohexane are diastereomers. \( \text{False} \)

7) A Lewis base that donates its two electrons to a (protic) Hydrogen is acting as a base. \( T \)

8) An epoxide is a 3 membered ring. \( T \)

9) $S_N^1$ and $E_1$ reactions both proceed through carbocation intermediates. \( T \)

10) Increasing the steric hindrance around the reaction center will increase the rate of $S_N^2$ reactions. \( \text{False} \)
11) Provide the correct full IUPAC names for the following molecules. (3+3=6pts)

(a) 3,3-Di-fluorocyclopentene

(b) (Z)-1-Bromo-1-Chlorobut-1-ene

12) i) Assign R or S to each chiral center in this Fischer projection. (4pts)

ii) Assign R or S to chiral centers A and B in this stick figure (line angle) diagram. (4pts)
13) Write the mechanism (i.e. curly arrows) for the below electrophilic addition. (3pts)

H₃C =CH₃

H₂C−F

H₃C−CH₃

H⁻F⁻

CH₃

H⁻F⁻

CH₃

H⁺

CH₃

H⁻F⁻

CH₃

+:F⁻

14) (4pts) The following alkyl bromide will undergo SN1 reaction with water, as shown below.

CH₃−CH₂−CH₂−CH₂−Br

H₂O

CH₃−CH₂−CH₂−OH

H−Br

Write the mechanism (i.e. curly arrows) for this SN1 process.
15) Provide the **reagents** for the first three, and **products** for the last three transformations. (12pts)

(a) 
\[
\begin{align*}
&\text{Br}_2 \\
\end{align*}
\]

(b) 
\[
\begin{align*}
&\text{BH}_3, \text{H}_2\text{O}_2, \text{NaOH} \\
&\text{CH}_3\text{CH}_2\text{CH} = \text{CH}_3 \\
&\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3
\end{align*}
\]

(c) 
\[
\begin{align*}
&\text{nCPBA} \quad \text{(any peroxycacid)} \\
&\text{cyclohexene} \\
&\text{cyclohexene}
\end{align*}
\]

(d) 
\[
\begin{align*}
&\text{OsO}_4, \text{H}_2\text{O}_2 \\
&\text{pentane} \\
&\text{pentane}
\end{align*}
\]

(e) 
\[
\begin{align*}
&\text{Hg(OAc)}_2, \text{H}_2\text{O} \text{ then } \text{NaBH}_4 \\
&\text{cyclohexene} \\
&\text{cyclohexene}
\end{align*}
\]

(f) 
\[
\begin{align*}
&\text{H-Br, Peroxides} \quad \text{(free radical initiator)} \\
&\text{alkene} \\
&\text{alkene}
\end{align*}
\]
I6) (7pts) For the molecules below:

a) Are A and B isomers? Yes

b) Indicate whether A or B is more stable. A

c) How many π bonds are in C? 1

d) For the transformation of A (and/or B) into C, what two atoms are removed? H & Br

e) What is the preferred geometric relationship between proton and leaving group for an E2 elimination? Anti CoPlanar

f) Under E2 elimination conditions, the production of C from either A or B differs in speed (reaction rate) by a factor of about 500 times. Which is faster, A → C or B → C?

g) Briefly explain your answer to part (f).

In B, the H and Br removed are arranged antiCoPlanar (the required geometry).
In A they are not antiCoPlanar.
**up to 2 BONUS POINTS**

The compound in question (12) part ii is "Xylitol", which is used as an artificial sweetener for drugs, toothpaste, confections and chewing gum.

Is Xylitol correctly described as a meso compound?

Yes (Achiral, but has chiral centers).

Based on your knowledge of the relationship between chirality and optical activity (rotation of plane polarized light), guess the optical rotation value (including + or - sign, and numerical value) for a 0.1M solution of Xylitol at room temperature.

0 (Zero, optically inactive since it is not chiral).