1. (5) Circle any nucleophile from the following:
   a) $^+\text{CH}_3$ b) BF$_3$ c) LiOCH$_3$ d) Br$_2$ e) None of the preceding

2. (5) Circle any electrophile from the following:
   a) HgCl$_2$ b) ethane c) $^-\text{CH}_3$ d) KCN e) None of the preceding

3. (3.5) Which of the following best explains the relative stabilities of the eclipsed and staggered forms of ethane? The _____ form has the most _____ strain.
   a) eclipsed; steric 
   b) eclipsed; torsional 
   c) staggered; steric 
   d) staggered; torsional

4. (3.5) Which of the following best explains the reason for the relative stabilities of the conformers shown at right?
   a) 1 has more torsional strain 
   b) 1 has more steric strain 
   c) 2 has more torsional strain 
   d) 2 has more steric strain

5. (4) The reaction shown at the right is of what type?
   a) addition 
   b) elimination 
   c) substitution 
   d) rearrangement
6. (3.5) Which point on the diagram at the right represents the transition state for conversion of the intermediate to products?

7. (4) True or False? This diagram represents a two-step reaction, such as the addition of HX to an alkene.

8. (5) The points (degrees) of unsaturation for the formula C₈H₉BrClNO₂ are:
   a) 3   b) 4   c) 5   d) 6   e) None of the preceding is correct.

9. (8) Assign E or Z to each of the following alkenes. You need not show the priorities of the attached groups.
   a) \[
   \begin{align*}
   &\text{H}_2\text{N} \\
   &\text{O} \\
   &\text{OH} \\
   &\text{O} \\
   &\text{H}\end{align*}
   \]
   b) \[
   \begin{align*}
   &\text{O} \\
   &\text{H} \\
   &\text{O} \\
   &\text{Cl} \\
   &\text{Br}\end{align*}
   \]

10. (8) Give an IUPAC name for the following molecule. Additionally, designate E or Z to the double bond.

11. (5) From the molecule shown, draw a Newman projection by viewing the molecule along the central C-C bond as designated below.
12. (10) Show an arrow (or arrows) indicating the movement of electrons (sharing) between each of the reaction pairs shown (one will be the nucleophile, the other the electrophile). You need not draw the result of your arrows.

a) \[ \text{BH}_3 + \text{C} \rightarrow \]

b) \[ \text{Br-Br} + \text{C} \rightarrow \]

13. (4.5) Which of the following describes the most stable conformer of \textit{trans}-1,2-dimethyl-cyclohexane?

a) There is a chair conformation and both methyl groups are axial
b) There is a chair conformation and both methyl groups are equatorial
c) There is a chair conformation and one methyl group is axial, the other equatorial
d) There is a boat conformation

14. (4) Circle the one most stable species shown below.

15. (5) Circle any two of the alkenes shown below which could react with excess hydrogen / Pd to form the product given.

16. (9) In each of the following nucleophiles, indicate with an arrow the atom which would react with an electrophile.

a) CH$_3$NH$_2$  b) H-S-CH$_2$CH$_3$  c) KH

17. (12) For each of the reactions shown below, indicate whether the overall process is a Markovnikov or anti-Markovnikov addition. \textbf{Note}: you may not have seen the reaction before.
18. (3) True or False? Very good nucleophiles would normally have a "real" positive charge.

19. (3) True or False? The first step in the oxymercuration process is attack of the alkene as a nucleophile upon the mercury of the mercuric acetate.

20. (3) True or False? If \textit{trans}-diaxial-1,2-dimethylcyclohexane were flipped to its alternate conformation, the resultant molecule would still be \textit{trans}.

21. (12) For each of the reactions shown below, indicate whether the \textbf{overall} process is a \textbf{Syn} or \textbf{Anti} addition. \textit{Note}: you may not have seen the reaction before.

22. (30) In each of the following reactions, either 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).... Show the stereochemistry of the products, as appropriate.
a) 

\[
\text{CH}_2 = \text{CH}_2 \underset{\text{Cl}_2}{\xrightarrow{\text{H}_2\text{O}}} \text{CH}_3\text{CH(OH)}\text{CH}_2\text{CH}_3
\]

b) 

\[
\text{C}_3\text{H}_5\text{H} \underset{\text{Cl}_2}{\xrightarrow{\text{H}_2\text{O}}} \text{C}_3\text{H}_5\text{OH}
\]

c) 

\[
\text{CH}_2 = \text{CH}_2 \underset{\text{KMnO}_4}{\xrightarrow{\text{NaOH, H}_2\text{O}}} \text{C}_9\text{H}_{16}\text{OH}
\]

d) 

\[
\text{C}_3\text{H}_7\text{H} \underset{\text{KMnO}_4}{\xrightarrow{\text{NaOH, H}_2\text{O}}} \text{C}_9\text{H}_{16}\text{OH}
\]

e) 

\[
\text{C}_3\text{H}_7\text{H} \underset{\text{HCl}}{\xrightarrow{}} \text{C}_9\text{H}_{16}\text{OH}
\]