Answer all 21 questions (150 pts). 

*1. (10) State whether each of the following is likely to be an electrophile or nucleophile.

a) HgSO₄  
b) KH  
c)  
d)  

*2. (7) Give an IUPAC name for the molecule shown below (include E or Z as appropriate).

*3. (8) For each of the reactions shown below, indicate whether the overall process is a Markovnikov or anti-Markovnikov addition. Note: you may not have seen the reaction before.

a)  
b)  

*4. (6) State whether each of the following reactions is an addition, rearrangement, elimination or substitution.

a)  
b)  

*5. (4) Which of the following describes the most stable conformer of cis-1-fluoro-3-methylcyclohexane?

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

*6. (8) For each of the reactions shown below, indicate whether the overall process is a Syn or
**Anti** addition. **Note:** you may not have seen the reaction before.

a)

b)

*7. (42) 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)

b)

K\textsubscript{MnO}_4, H\textsubscript{3}O\textsuperscript{+}

vigorous conditions

c)

Cl\textsubscript{2} (2 equivalents)
8. (8) In each example below, draw the arrow-pushing mechanism leading to the products shown.

a) \[ \text{O} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{O} + \text{H}_2\text{O} \]

b) \[ \text{O}_2\text{H} + \text{HO}^- \rightarrow \text{O}_2\text{H}^- + \text{H}_2\text{O} \]

9. (6) For each example shown in Question 8 above (a and b), label which reactant is the nucleophile and which is the electrophile.

10. (4) Draw the molecule shown below as its (E) isomer.

\[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}==\text{CHCH}_3 \]

11. (7) A molecule with 3 degrees of unsaturation could contain which of the following? Circle all which apply.

a) 1 ring and 1 double bond  
 b) 2 rings  
 c) 3 rings  
 d) 1 triple bond  
 e) 3 double bonds  
 f) 2 rings and 1 double bond  
 g) 1 ring and 1 triple bond

12. (5) Fill in each of the following missing blanks using one of the choices in parentheses.

The reaction of an alkene with Br₂ is a _____-(one, two, three)-step reaction involving a _____________(bromonium; carbocation; transition state) intermediate.

13. (4.5) For the following, circle all of the statements to the right which are correct as shown.

- syn addition
- anti addition
- Markovnikov
- anti-Markovnikov
- hydration
- hydrogenation

14. (2.5) True or False? A syn addition to an alkene can not give a trans product.

15. (2.5) True or False? Very good nucleophiles would normally have a "real" positive charge.
**16.** (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.

**17.** (3) True or False? If cis-diequatorial-1,2-dichlorocyclohexane were flipped to its alternate conformation, the resultant molecule would still be cis.

**18.** (4) How many degrees of unsaturation are there in C₈H₅BrFNO? You need not show your work.

**19.** (4) Circle any compounds shown below that could be possible products from addition of Br₂ to 1-butene.

a) ![Chemical Structure](a)

b) ![Chemical Structure](b)

c) ![Chemical Structure](c)

d) ![Chemical Structure](d)

**20.** (7.5) Some reactions are 2-step processes. In such cases, the reactions involve an unstable, but real, species called the _________. Addition to an alkene from the opposite side is called _______. A specific example of addition to the same side of an alkene is the addition of ________.

**21.** (4) What is the major product formed when two equivalents of HCl react with 1-propyne?

a) CH₃CH₂CHCl₂    b) CH₂CCl₂CH₃    c) CH₂CH=CHCl    d) CH₂CCl=CH₂