1. Classify each of the following reactions as an oxidation, a reduction, or neither.

a. \[
\text{BH}_2 \xrightarrow{\text{H}_2\text{O}_2 / \text{OH}^{-1}} \text{OH}
\]

b. \[
\text{OH} \xrightarrow{\text{LAH} / \text{TiCl}_4} \text{Br}
\]

c. \[
\text{Br} \xrightarrow{\text{Br}_2 / \text{light}} \text{OH}
\]

2. Give systematic (IUPAC) names for the following.

\[
\text{Me} \quad \text{OH}
\]

\[
\text{Me} = \text{methyl}
\]

3. Arrange the following compounds in order of decreasing acidity - STRONGEST ONE FIRST

IF YOU DO THIS BACKWARDS YOU WILL ONLY GET ONE POINT

\[
\text{CH}_3\text{CH}_2\text{OH}, \text{CH}_3\text{CH}_2\text{SO}_3\text{H}, \text{CH}_3\text{CH}_2\text{SH}, \text{F-CH}_2\text{CH}_2\text{SH}, \text{CH}_3\text{CH}_2-\equiv-\text{H}
\]

\[
\text{A} \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E}
\]
4. An unknown compound has a molecular formula $C_6H_6O_2$. It reacts with three equivalents of hydrogen in the presence of Pt.
   a) How many units (elements) of unsaturation are present in the unknown. _______
   b) How many rings are in the unknown. ____________________
   c) Draw a possible structure for the unknown compound. We will accept only stable compounds.

5. Two bottles have lost their label but were known to contain either fumaric acid or maleic acid. The structures are given below.

- Fumaric acid
- Maleic acid

Sample from bottle A
1. $m$-CPBA
2. $\text{HOH/H}^+$

Sample from bottle A
1. $m$-CPBA
2. $\text{HOH/H}^+$

Now a sample was taken from each bottle (let’s call them Bottle A and Bottle B) and each was treated with $m$-chloroperbenzoic acid ($m$-CPBA) and the resulting epoxide hydrolyzed to tartaric acid derivative/s. Upon work up of each reaction mixture the sample from BOTTLE A was found to yield meso-tartaric acid and BOTTLE B yielded a racemic mixture ($\pm$) of tartaric acids. Recall that the general structure of the tartaric acids is: $\text{HO}_2\text{C-CH(OH)-CH(OH)-CO}_2\text{H}$. Indicate which bottle contained fumaric acid and which bottle contained maleic acid. The reactions are summarized above.

YOU MUST SHOW EITHER A SAWHORSE OR FISHER PROJECTION FOR THE TARTARIC ACID/S FORMED.
6. Write structures for the important intermediate in the following reactions.
   
   a. Chlorination of 1-butene

   b. Hydration of 1-butene with Hg(OAc)$_2$

   c. Initially formed intermediate in the reaction of 2-butyne with Na/NH$_3$ (3-D structure required as is orbital representation non-bonded atoms such as radical, carbanion, or cation if appropriate.

7. SYN vs. ANTI – Indicate which set of reagents will result in the following reactions.

   a. $trans$-3-methyl-2-pentene $\rightarrow$ erythro-3-methyl-2-pentanol

   b. $cis$-2-butene $\rightarrow$ threo-2-ethoxy-3-bromobutane (ethoxy = EtO-)

   c. $cis$-3-hexene $\rightarrow$ meso-3,4-hexanediol
8. Write structures of the major product/s in the following reactions.

a. propyne + HBr (excess)

b. 1,1-dibromopentane $\xrightarrow{\text{fused KOH}}$ 200 °C

c. 1-butyne $\xrightarrow{\text{HOH/HgSO}_4}$ $\xrightarrow{\text{H}_2\text{SO}_4}$

d. cyclopentene $\xrightarrow{\text{ICH}_2\text{ZnI}}$ (Simmon-Smith)

 e.  

$\xrightarrow{\text{NaBH}_4/\text{MeOH}}$

me = methyl

f.  

$\xrightarrow{\text{PCC}}$

pyridinium chlorochromate
8. continued.

\[
\begin{align*}
g. & \quad \text{Me} \quad \text{Me} \quad \frac{\text{H}_2}{\text{Lindlar Catalyst}} \\
h. & \quad \text{CH}_3
\end{align*}
\]

9.
From which of the following compounds could one prepare a stable Grignard reagent. Give structure of stable Grignard reagent that would be formed in each case shown below.

\[
\begin{align*}
\text{H} & \quad \text{Mg} / \text{Et}_2\text{O} \\
\text{Br} & \quad \text{Mg} / \text{Et}_2\text{O} \\
\text{OMe} & \quad \text{Mg} / \text{Et}_2\text{O}
\end{align*}
\]

10. Write the two particularly stable resonance structures for 2,4-dinitrophenoxyde, which is the conjugate base of 2,4-dinitrophenol.
11. Carry out the following preparations starting from compound stated in question shown below and any inorganic and/or organic compounds.

a. Starting material

b. \( \text{PhC} = \text{O} \text{Me} \)  

\( \text{Me} = \text{methyl} \)

c. Acetaldehyde (\( \text{CH}_3\text{CHO} \))  

Using organometallic compounds and appropriate oxidizing reagents
12. Give major product/s and mechanisms, all steps for the following reactions.

\[
\text{I}_2 / \text{added Br}^-
\]

iodo bromo product

13. Which one in the following pair has greater water solubility.

n-Butanol or t-butyl alcohol

14. Which one in the following pair has the higher boiling point

1-butanol or 1-butanal

15. Myrcene, C\textsubscript{10}H\textsubscript{16} is found in oil of bay leaves. It reacts with three equivalents of H\textsubscript{2} to give C\textsubscript{10}H\textsubscript{22}. Ozonolysis followed by Me\textsubscript{2}S (me = methyl) treatment of myrcene yields formaldehyde (CH\textsubscript{2}O), acetone (MeCOMe), and 2-oxopentanodial, whose structure is shown below.

Deduce a possible structure for myrcene.
BONUS QUESTIONS - DO LAST.

Give the mechanism for the following biological oxidation.

\[
\text{ADH} \\
\text{Pro-R ethanol} + \text{NAD}^+ \rightarrow \text{acetaldehyde} + \text{NADH}
\]