1. Label the following reaction as oxidation, reduction, or neither.

2. Label the following reaction as oxidation, reduction, or neither.

3. Given that syn addition of H₂ occurs from both sides of trigonal planar double bond, draw all stereoisomers formed when the alkene is treated with H₂. Be sure to answer all parts.

   Trans isomer

   Cis isomer
4. For alkenes A, B, and C, draw the products formed when each alkene is treated with ozone, followed by Zn, H₂O.
5. What product, including stereochemistry, is formed when
\[
\text{CH}_3\text{OCH}_2\text{CH}_2\text{C} = \text{CCH}_2\text{CH}(_3)\text{CH}_2
\]
Is treated with the following reagent:

\[
\text{H}_2 \text{ (excess). Lindlar catalyst?}
\]

6. Draw all stereoisomers formed when the following alkene is treated with mCPBA.

\[
\text{H}_3\text{CH}_2\text{C} = \text{CH}_2\text{CH}_3
\]

How many stereoisomers of the product are possible?

Draw the product of the reaction, including stereochemistry.

7. Draw the products formed when both cis- and trans-2- butane are treated with OsO4, followed by hydrolysis with NaHSO3+H2O.

a) How many unique stereoisomers exist for the product of the reaction involving cis-2-butene?

b) The two possible stereoisomers are identical meso compounds.
c) How many unique stereoisomers exist for the product of the reaction involving *trans*-2-butene?

d) The reaction is stereospecific because:

A. It yields predominantly or exclusively one constitutional isomer when more than one is possible.
B. *Cis*-2-butene and *trans*-2-butene yield different stereoisomers.

e) The reaction is stereospecific because:

A. It yields predominantly or exclusively one constitutional isomer when more than one is possible.
B. *Cis*-2-butene and *trans*-2-butene yield different stereoisomers.

8. Draw the product formed when both *cis*- and *trans*-2-butene are treated with a peroxycacid followed by −OH (in H₂O). Explain how these reactions illustrate that antidihydroxylation is stereospecific. Be sure to answer all parts.

a) How many unique stereoisomers exist for the product of the reaction involving *cis*-2-butene?
b) Draw the products of the reaction involving cis-2-butene.

\[
\begin{align*}
\text{cis-2-butene} & \quad [1] \text{RCO}_3\text{H} \\
& \quad [2] \text{H}_2\text{O}, \text{HO}^- \\
\end{align*}
\]

\[
\begin{align*}
s,s & \quad + \\
r,r & \\
\end{align*}
\]

c) How many unique stereoisomers result from the reaction involving trans-2-butene?

d) The two possible stereoisomers that result are identical meso compounds. Draw the product of the reaction involving trans-2-butene.

\[
\begin{align*}
\text{trans-2-butene} & \quad [1] \text{RCO}_3\text{H} \\
& \quad [2] \text{H}_2\text{O}, \text{HO}^- \\
\end{align*}
\]

e) The reaction is stereospecific because:

A. Two stereoisomeric starting materials give different products that are also stereoisomers of each other.
B. It yields predominantly or exclusively one constitutional isomer when more than one is possible.

9. What alkene yields the following products after treatment with \(O_3\) followed by \(\text{CH}_3\text{SCH}_3\)?

\[
\begin{align*}
\text{products} & 
\end{align*}
\]

and two equivalent of \(\text{CH}_2=\text{O}\)
10. What alkyne (or diyne) yields the following oxidative cleavage products?

\[ \text{CH}_3\text{CH}_2\text{CO}_2\text{H}, \text{HO}_2\text{CCH}_2\text{CO}_2\text{H}, \text{CH}_3\text{CO}_2\text{H} \]

11. Draw the organic product of the following reaction.

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

12. Draw the organic product of the following reaction.

\[ \text{OH} \quad \text{CrO}_3 \quad \text{H}_2\text{SO}_4, \text{H}_2\text{O} \]

13. Draw the product of the following Sharpless epoxidation, including stereochemistry.

\[ \text{OH} \quad \frac{(\text{CH}_3)_3\text{C-OOH}}{\text{Ti}[\text{OCH(CH}_3)_2]_4} \quad (-)\text{-DET} \]
14. It is sometimes necessary to isomerize a cis alkene to a trans alkene in a synthesis, a process that cannot be accomplished in a single step. Using reactions you have learned, draw the correct product for each step of the following stepwise method to convert cis-2-butene to trans-2-butene.

\[
\begin{align*}
\text{Br}_2 & \quad \text{NH}_2^+ \\
(C_2H_4) & \quad (2\text{ equiv}) \\
& \quad \text{Na} \quad \text{NH}_3
\end{align*}
\]

15. Devise a synthesis of the following compound from styrene. You may use any inorganic or organic reagents. More than one step is required.

\[
C_6H_5CH(OH)CH_2C\equiv CH
\]
16. Devise a synthesis of the product compound from the indicated starting material and the given reagents.

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} & \rightarrow \text{H}_3\text{CCH}_2\text{CH}_3 \\
\end{align*}
\]
17. Devise a synthesis of the following compound from ethynylcyclohexane. You may use any of other required reagents.