I'll bet living in a nudist colony takes all the fun out of Halloween. ~ Anonymous.
1. Give the major product or products for the following reactions. Be aware of details like rearrangements, Z&E, cis and trans, stereochemistry, regiochemistry, etc. (4 pts each) Label any stereocenter formed as R or S. (8 pts)

a. \[ \text{Br} \xrightarrow{1) \text{EtOH, heat}} \rightarrow \text{S} \xrightarrow{2) \text{CH}_2\text{I}_2, \text{Zn}} \text{R} \] (meso compound, no enantiomer)

b. \[ \text{1) BH}_3\text{-THF} \rightarrow \text{S} \xrightarrow{2) \text{H}_2\text{O}_2, \text{KOH}} \text{OH} \]

c. \[ \text{Br} \xrightarrow{1) \text{KOTBu, HOtBu}} \rightarrow \text{OH} \xrightarrow{2) \text{Cl}_2, \text{H}_2\text{O}} \text{Cl} \]

d. \[ \text{OH} \xrightarrow{1) \text{H}_3\text{PO}_4} \rightarrow \text{R} \xrightarrow{2) \text{mCPBA, CH}_2\text{Cl}_2} \text{S} \]
2. a. Draw all products from the reaction of (3S)-1,3-dimethylcyclopent-1-ene with Br₂. Label each stereocenter (if any) R or S. (7 pts)

b. How many stereocenters are present in one of the products? How many total possible stereoisomers does this compound have? What is the relationship between all the products you have drawn? (6 pts)

Three stereocenters. Eight possible stereoisomers. The two stereoisomers above are diastereomers.

(Points were awarded if answers were self consistent with drawings)

c. Draw another different stereoisomer from your products. Label each stereocenter, if any, R or S. What is the relationship between your new drawing and the original products? (5 pts)

Any reasonable drawing accepted. The relationship must be stated for each of the above drawings.

d. If one of your stereoisomers had an [α]D of −15°, and a solution of that stereoisomer gave an observed rotation of 10°, what is the e.e. of the solution? (2 pts) How much of each stereoisomer do you have? (2 pts)

Pure (-) has [α]D = −15°. Solution is + 10°, so there is extra (+). There is 2/3 extra (+), so the e.e. = 66.7% (+). There is 66.7% extra (+) and a 33.3% mixture of (+) and (-), or an additional 16.6% each of (+) and (-). This gives a total of 83.3% (+) and 16.6% (-).
3. Give reagents or a set of reagents that would perform the following transformation. Be aware that there may be multiple correct answers. (5 pts each)

a. \[
\begin{array}{c}
\text{I} \\
\text{HO} \\
\text{2) any alcohol forming reaction (you know four!)} \\
\end{array}
\]

b. \[
\begin{array}{c}
\text{OH} \\
\text{O} \\
\text{2) O} \\
\text{3) CH}_3\text{SCH}_3 \text{ or Zn} \\
\end{array}
\]

4. Draw step by step mechanisms to account for the products shown for two of the next three reactions. There may be other products formed, but you do not need to account for them in your mechanisms. Be sure to draw arrows to account for the flow of electrons and show all steps. (12 pts each)

a. \[
\begin{array}{c}
\text{H-Br} \\
\end{array}
\]

b. \[
\begin{array}{c}
\text{Hg(OAc)}_2, \text{H}_2\text{O} \\
\end{array}
\]

c. \[
\begin{array}{c}
\text{H}_3\text{O}^+ \\
\text{HO} \\
\text{OH} \\
\text{Br} + \text{Br}^2 \\
\end{array}
\]

\[
\begin{array}{c}
\text{I:} \\
\text{O} \leftrightarrow \text{2:} \\
\text{O} + \text{H-Br} \rightarrow \text{OH} + \text{Br} \\
\text{P:} \\
\text{Br} + \text{H-Br} \rightarrow \cdot \text{Br} \\
\text{Br} + \text{H-Br} \rightarrow \cdot \text{Br} + \text{Br} \\
\text{T:} \\
\text{Br} + \cdot \text{Br} \rightarrow \text{Br}_2
\end{array}
\]
5. What is the best description of the relationship between the following pairs of compounds? Choose only four of the next five. You choices are: same compound; resonance structure; structural (or constitutional) isomer; geometric isomer; enantiomer; diastereomer; or completely different compound. (5 pts each)

a. 

\[
\begin{align*}
\text{CO}_2\text{H} & \quad \text{Br} \\
\text{H} & \quad \text{CH}_3 \\
\text{H} & \quad \text{Br} \\
\text{CO}_2\text{H} & \quad \text{Br} \\
\text{H} & \quad \text{H} \\
\end{align*}
\] 

and 

\[
\begin{align*}
\text{CH}_3 & \quad \text{H} \\
\text{H} & \quad \text{Br} \\
\text{Br} & \quad \text{H} \\
\text{CO}_2\text{H} & \quad \text{H} \\
\end{align*}
\] 

(HOMEWORK QUESTION) same compound

b. 

\[
\begin{align*}
\text{OH} & \quad \text{OH} \\
\text{H} & \quad \text{H} \\
\end{align*}
\] 

and 

\[
\begin{align*}
\text{HO} & \quad \text{OH} \\
\text{H} & \quad \text{HO} \\
\text{OH} & \quad \text{H} \\
\end{align*}
\] 

same compound

c. 

\[
\begin{align*}
\text{HO} & \quad \text{CH}_3 \\
\text{H} & \quad \text{H} \\
\text{H} & \quad \text{OH} \\
\text{CH}_2\text{OH} & \quad \text{H} \\
\end{align*}
\] 

and 

\[
\begin{align*}
\text{H}_2\text{C} & \quad \text{H} \\
\text{H} & \quad \text{CH}_2\text{OH} \\
\text{HO} & \quad \text{H} \\
\text{HO} & \quad \text{H} \\
\end{align*}
\] 

(HOMEWORK QUESTION) enantiomer

d. 

\[
\begin{align*}
\text{CHO} & \quad \text{H} \\
\text{H} & \quad \text{CH}_3 \\
\text{H} & \quad \text{CH}_3 \\
\text{CH}_3 & \quad \text{H} \\
\text{H} & \quad \text{CHO} \\
\end{align*}
\] 

and 

\[
\begin{align*}
\text{CHO} & \quad \text{H} \\
\text{H} & \quad \text{CH}_3 \\
\text{H} & \quad \text{CH}_3 \\
\text{CH}_3 & \quad \text{H} \\
\text{H} & \quad \text{CHO} \\
\end{align*}
\] 

(HOMEWORK QUESTION) diastereomer

e. 

\[
\begin{align*}
\text{CH}_2\text{OH} & \quad \text{H} \\
\text{H} & \quad \text{OH} \\
\text{H} & \quad \text{H} \\
\text{Cl} & \quad \text{H} \\
\text{CH}_3 & \quad \text{H} \\
\end{align*}
\] 

and 

(2R, 3R)-3-chloropentan-1,2-diol structural isomer

(3) BONUS: Name your favorite three pieces of Halloween candy. Any reasonable answer accepted.