1. Rank the reactivity of the following molecules toward Br₂/hv. (1 most, 4 least) (3 points)

Radical Stability

\[
\begin{array}{ccc}
\text{CH}_3\text{-CH}_3 & \text{C}_5^0 & \text{C}_6^0 \\
<1 & 3 & 1 & 2 \\
10 & 20 & 30 \\
\end{array}
\]

2. Rank the reactivity of the following molecules toward ethanol and AgNO₃. (1 most, 4 least) (3 points)

Cation stability (+resonance) 
Leaving Group

\[
\begin{array}{cccc}
\text{Br} & \text{Cl} & \text{Cl} & \text{Br} \\
2 & 3 & 4 & 1 \\
\end{array}
\]

3. Rank the reactivity of the following molecules toward NaOCH₃. (1 most, 4 least) (3 points)

\[
\begin{array}{cccc}
\text{Br} & \text{I} & \text{Br} & \\
4 & 1 & 3 & 2 \\
\end{array}
\]

4. Rank the reactivity of the following toward 1-iodopropane. (1 most, 4 least) (3 points)

\[
\begin{array}{cccc}
\text{CH}_3\text{ONa} & \text{CH}_3\text{CO}_2\text{H} & \text{CH}_3\text{CO}_2\text{Na} & \text{CH}_3\text{SNa} \\
2 & 4 & 3 & 1 \\
\end{array}
\]

5. What is the hybridization of a carbocation? (2 points)

\[
\begin{array}{c}
\text{Le} \\
\text{sp}^2
\end{array}
\]
6. Predict the major organic product (1 major structure is all that is needed in each case) for each of the following reactions. (Minor products or inorganic side products need not be drawn.) (3 points each)

\[
\text{SN2}
\]

\[
\text{S}_{\text{N}2}, \text{ inversion}
\]

7. Draw the structures for intermediate A and final product B. (4 points)

8. Draw the product when the following substance undergoes E2 elimination. ("D" is deuterium, basically just a labelled hydrogen). If the starting material is optically active, will the product be optically active? (4 points)
9. Show an alkyl bromide and some nucleophile that you could use to make the following by $S_N2$. (3 points each)

$$\text{Electrophile: methyl OK}$$

$$\text{3rd X not OK}$$

$$\text{For this gauche}$$

$$\text{both trisub, both OK at } S_N2$$

10. Draw all possible elimination products that could form from the following reactant. Circle the one that forms in greatest yield. (5 points)

$$\text{minor}$$

$$\text{both trisub}$$

**Oops, you wouldn't know which is better!**

11. Which of the following would not increase the rate of an $E1$ reaction? (3 points)
   a. an increase is temperature
   b. an increase in the "activation energy"
   c. an increase in the concentration of the alkyl halide
   d. an increase in the stability of the carbocation intermediate

12. When comparing the reaction of 2-methylpropane with either Cl$_2$/hv or Br$_2$/hv, which of the following statements is true? (3 points)
   a. bromine is less reactive and more selective
   b. chlorine is less reactive and more selective
   c. bromine is more reactive and more selective
   d. chlorine is more reactive and more selective

13. Which of the following statements is true relative to reactions I-III: (3 points)

   I  $\text{CH}_4 + \text{Br}^* \rightarrow \text{CH}_3^* \text{ and HBr}$
   II $\text{CH}_3\text{CH}_3 + \text{Br}^* \rightarrow \text{CH}_3\text{CH}_2^* + \text{HBr}$
   III $\text{CH}_3\text{CH}_2\text{CH}_3 + \text{Br}^* \rightarrow (\text{CH}_3)_2\text{CH}^* + \text{HBr}$

   a. I has the smallest energy of activation and the highest energy transition state
   b. II has the smallest energy of activation and I has the lowest energy transition state
   c. III has the largest energy of activation and the highest energy transition state
   d. III has the smallest energy of activation and the lowest energy transition state
14. Classify each of the chiral carbons in the following structures as (R) or (S). (10 points)

![Chemical structures](image)

15. a. Classify each pair of molecules as diastereomers, enantiomers, or same. (12 points)
b. Circle any molecules that are chiral
c. Write "meso" by any structures that are meso

![Chemical structures](image)

16. Which of the following statements is true? (3 points)
   a. All solutions with chiral molecules are optically active
   b. All molecules with chiral carbons are chiral
   c. A solution that has 50% optical purity has a 50/50 mixture of enantiomers
   d. Two enantiomers always have identical boiling points

17. Draw (2R,3S)-2-bromo-3-chlorohexane (3 points)

![Chemical structure](image)

18. Name the following: (3 points)

![Chemical structure](image)
19. a) Draw all unique stereoisomers of 2,4-dibromopentane. Label each with a letter, A, B, etc.. Cross out any duplicates. (8 points)
b) Identify any that are chiral
c) Identify any that are meso

20. a) Draw the mechanism for the following reaction. (Draw the propagation steps only.) (4 points)
b) Is your product chiral, and if so is it optically active? (1 point)

21. a) Draw the mechanism for the following reaction. (4 points)
b) Identify the slow step. (1 point)