1. Draw the structure of the carbocation intermediate and the major reaction product for each of the following reactions. Be sure to include and pertinent stereochemistry.

(a) \[ \text{CH}_3\text{CH}_2\text{CH:CCH}_2\text{CH}_3 + \text{HCl} \]

(b) \[ 1\text{-Ethylcyclopentene} + \text{HBr} \]

(c) \[ 2,2,4\text{-Trimethyl-3-hexene} + \text{HI} \]

(d) \[ 1,6\text{-Heptadiene} + 2 \text{HCl} \]

(e) \[ \text{CH}_3 + \text{HBr} \]

2. Propose a mechanism to account for the following reactions. Show the structure(s) of all intermediates and use curved arrows to indicate the electron flow in each step.

(a) \[ \text{+ HCl} \]

(b) \[ \text{+ HCl} \]

3. Draw a reaction energy diagram for the addition of HBr to 1-pentene. Let one curve on the diagram show the formation of 1-bromopentane and another curve on the same diagram show the formation of 2-bromopentane. Label the positions for all reactants, intermediates and products. State which alkyl bromide would be the major product and why. [Notice! which curve has the higher energy carbocation intermediate and higher energy first transition state. Since these two possible reactions would be competing with each other, think about why there would be a much greater amount of one product relative to the other.]

4. The following reaction takes place in high yield. Even though you have never seen this reaction before, use your general knowledge of alkene chemistry to propose a mechanism for the transformation. The reaction conditions contain no water.
5. When 4-penten-1-ol is treated with aqueous bromine, a cyclic bromo ether is formed, rather than the expected bromohydrin (bromine and hydroxy groups on adjacent carbons). Propose a mechanism. Show the intermediate!

\[
\text{H}_2\text{C}=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{OH} \xrightarrow{\text{Br}_2/\text{H}_2\text{O}} \text{OCH}_2\text{Br}
\]

6. Predict the products of the following reactions (also show the structure of intermediates A and B). Show stereochemistry!

\[
\text{Br}_2 \\
\text{dilute Br}_2 \xrightarrow{\text{H}_2\text{O}} (\text{These conditions favor bromohydrin formation})
\]

7. When propene is treated with hydrogen chloride in ethanol, one of the reaction products is ethyl isopropyl ether [\text{CH}_3\text{CH}_2\text{O}-\text{CH(}\text{CH}_3)_2]. Write a plausible mechanism that accounts for the formation of this product.

8. You know the mechanism of HBr addition to alkenes. Use this knowledge to predict which of the following two alkenes reacts faster with HBr. Explain your answer by drawing resonance structures of the carbocation intermediates.

\[
\text{CH}_3\text{O} \\
\text{O}_2\text{N}
\]

9. Benzyl bromide is converted into benzaldehyde by heating in dimethyl sulfoxide. Propose a structure for the intermediate (A) and show the mechanisms of the two steps in the reaction. (Old reactions will not disappear)

\[
\text{CH}_3\text{Br} + \text{S}_2\text{SOCH}_3 \xrightarrow{\text{S}_2\text{N2 reaction}} \text{A} \xrightarrow{\text{E2 reaction}} \text{Benzaldehyde}
\]

10. Suggest a plausible synthesis for each of the following molecules starting from 1-bromo-1-methylcyclohexane. You can use any reagents that we have encountered over the past two terms.
11. Briefly explain why oxymercuration of a terminal alkyne followed by treatment with aqueous acid produces a methyl ketone instead of an aldehyde.

12. Briefly explain why the mercury does not have to be removed using NaBH₄ when you react an alkyne with mercuric acetate but does when you react with an alkene.

13. Give the reaction conditions which will complete the following transformations.

14. Briefly explain why radical addition of HBr across an alkene gives the anti-Markovnikov addition product.

15. Draw out a mechanism for the allylic bromination of cyclopentene using N-bromosuccinimide and light.

16. Briefly explain why radical addition of HBr across an alkene or alkyne works but the analogous reactions using HCl or HI fail.