1. (a) Show the mechanism of the following reaction. Label the rate-limiting step. (b) Draw the potential energy diagram for this reaction. (c) Explain the regiochemistry of this reaction. Why was 1-bromo-2-methylcyclohexane not formed?
(c) Formation of 1-bromo-2-methylcyclohexane would result from anti-Markovnikov addition. This does not occur because the intermediate carbocation formed in the RDS would be 2°. Formation of a 2° cation requires more energy than formation of a tertiary cation. Hence, the pathway with the lower activation energy is favored.

2. For the following reactions involving addition of hydrogen halides, stereochemistry of the products may be significant. In each case, indicate if the product(s) are chiral or achiral, and whether the product mixture is optically active or optically inactive.

(a) HI

\[
\begin{align*}
\text{achiral} \quad \text{optically inactive} & \quad \text{achiral} \quad \text{optically inactive} \\
\end{align*}
\]

(b) HCl

\[
\begin{align*}
\text{achiral} \quad \text{optically inactive} & \quad \text{chiral} \quad \text{racemic mixture} \quad \text{optically inactive} \\
\end{align*}
\]

(c) HBr

\[
\begin{align*}
\text{achiral} & \quad \text{chiral} \quad \text{chiral} \\
\text{50:50 mixture of diastereomers} \quad \text{optically active} \\
\end{align*}
\]
3. Show the mechanism that explains the following results.

4. Show the mechanism of reaction for each of the following. Label the rate-limiting step. Show stereochemistry, when appropriate.

(a) Stereochemistry is not necessarily important in this reaction. If a new chiral center is formed, enantiomers would result.
Stereochemistry is important here. Illustration of anti-addition is part of the mechanism.

Stereochemistry is also important here. It’s a bit trickier to show in this case, because the two groups being added (–Br and –OH) are not the same, like in the previous problem.
Stereochemistry is not important in this reaction – only regiochemistry. However, for you stereochemistry nuts – since two new chiral centers are produced, this reaction would yield a total of 4 stereoisomers.
chain propagating

5. Show the mechanism that explains the following results.
6. Show all products of the following reactions. Label major and minor products, as necessary. Show stereochemistry, as necessary.

(a)  
\[
\text{HCl} \quad \rightarrow \quad \text{Cl}
\]

(b)  
\[
\text{HI} \quad \rightarrow \quad \text{I} + \text{I}
\]
(c) \[ \text{CH}_3\text{C}≡\text{CHCH}_3 \rightarrow \text{HBr} \rightarrow \text{CH}_3\text{C}―\text{CH}_2\text{CH}_3 \]

(d) \[ \text{CH}_3\text{C}≡\text{CHCH}_3 \rightarrow \text{HBr} \rightarrow \text{ROOR} \rightarrow \text{CH}_3\text{C}―\text{CH}_2\text{CH}_3 \]

(e) \[ \text{Cyclohexene} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{Cyclohexanol} \]

(f) \[ \text{Cyclohexene} + \text{BH}_3 \cdot \text{THF} \rightarrow (2) \text{H}_2\text{O}_2, \text{OH}^- \rightarrow \text{Cyclohexane} \]

(g) \[ \text{1,3-Butadiene} \rightarrow \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{CH}_2\text{CH}_3\text{CHOH} + \text{CH}_3\text{OH} \]

(h) \[ \text{Cyclohexene} \rightarrow \text{Br}_2 \rightarrow \text{Br} \]
(i) \[ \text{Cl}_2 \xrightarrow{\text{H}_2\text{O}} \underset{\text{Cl}}{\text{H}} \text{OH} + \underset{\text{H}}{\text{OH}} \text{Cl} \]

(j) \[ \text{Br}_2 \xrightarrow{\text{H}_2\text{O}} \underset{\text{Br}}{\text{H}} \text{OH} + \underset{\text{Br}}{\text{H}} \text{OH} \text{CH}_3 \]

(k) \[ \text{H}_2 \xrightarrow{\text{Pt}} \underset{\text{CH}_3}{\text{CH}} \text{CH}_3 \]

(l) \[ \text{CH}_3\text{CO}_3\text{H} \xrightarrow{\text{CH}_3\text{CO}_3\text{H}} \underset{\text{H}}{\text{H}} \]

(m) \[ \text{CH}_3 \text{CH} = \text{CH} \text{CH}_3 \xrightarrow{\text{CH}_3\text{CO}_3\text{H}} \underset{\text{O}}{\text{O}} \text{O} \text{CH}_3 \text{CH}_3 \text{CH}_3 \text{CH}_3 \]

(n) \[ \text{CH}_3\text{CH}_2\text{CH} = \text{CHCH}_3 \xrightarrow{(1) \text{O}_3} \text{CH}_3\text{CH}_2\text{CH} = \text{O} + \text{O} = \text{CHCH}_3 \]

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7. Write the reagents needed to achieve the following transformations.

(a) \[
\text{O} = \text{HC} = \text{CH} \ \text{CH} \ \text{CH} \ \text{CH} = \text{O}
\]

\[
\text{(1) } \text{O}_3 \\
\text{(2) Zn, H}_2\text{O}
\]

(b) \[
\text{CH}_3\text{C} \equiv \text{CH}
\]

\[
\text{HI}
\]

(c) \[
\text{CH}_3\text{CH} \equiv \text{CH}
\]

\[
\text{H}_2 \ 	ext{Rh}
\]

(d) \[
\text{CH}_3\text{CH} \equiv \text{CH}
\]

\[
\text{HBr} \ 	ext{ROOR}
\]

(e) \[
\text{CH}_3\text{CH} \equiv \text{CH}
\]

\[
\text{H}_2\text{O} \ 	ext{H}_3\text{PO}_4
\]

(f) \[
\text{CH}_3\text{CH} \equiv \text{CH}
\]

\[
\text{(1) } \text{BH}_3 \cdot \text{THF} \\
\text{(2) } \text{H}_2\text{O}_2, \text{OH}^-
\]

(g) \[
\text{CH}_3\text{C} \equiv \text{CH}
\]

\[
\text{Cl}_2 \ 	ext{H}_2\text{O}
\]

(h) \[
\text{CH}_3\text{C} \equiv \text{CH}
\]

\[
\text{Cl}_2
\]
8. Show the structure of the alkenes that would produce the following compounds by ozonolysis.

(a) \( \text{CH}_3\text{C} \equiv \text{CH}_3 + (\text{CH}_3)_2\text{CHCH}=\text{O} \rightarrow \text{CH}_3\text{C} \equiv \text{CHCH}(\text{CH}_3)_2 \)

(b) \( \text{CH}_3\text{C} \equiv \text{CH}_3 + \text{H}_2\text{C}=\text{O} \rightarrow \text{CH}_3\text{C} \equiv \text{CH}_2 \)

(c) \( \text{CH}_3\text{CH}_2\text{CH}=\text{O} \rightarrow \text{CH}_3\text{CH}_2\equiv\text{CHCH}_2\text{CH}_3 \)

9. Show the structure of the intermediate (organoborane) that would form when a borane (let’s say \( \text{R}_2\text{BH} \)) reacts with 2-methylbut-2-ene.

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10. Suggest a sequence of reactions suitable for preparing each of the following compounds from the indicated starting material. You may use any necessary organic or inorganic reagents.

(a) 1-propanol from 2-propanol

(b) 1-bromopropane from 2-bromopropane

(c) 1,2-dibromopropane from 2-bromopropane

(d) 1-bromo-2-propanol from 2-propanol

(e) 1,2-epoxypropane from 2-propanol

(f) 2-methyl-2-propanol from 1-bromo-2-methylpropane

(g) t-butyl iodide from 1-iodo-2-methylpropane
(h) *trans*-2-chlorocyclohexanol from chlorocyclohexane

(i) Iodocyclopentane from cyclopentane

(j) *trans*-1,2-dichlorocyclohexane from cyclohexane