1.) Which alkene would yield 3-methylpentane when subjected to catalytic hydrogenation?

A) \[
\begin{align*}
\text{CH}_3&\text{C}=\text{CH}_2 \\
&\text{CH}_2\text{CH}_2\text{CH}_3 \\
\end{align*}
\]

B) \[
\begin{align*}
\text{H}&\text{C}=\text{C} \\
&\text{CHCH}_2\text{CH}_3 \\
&\text{CH}_3 \\
\end{align*}
\]

C) \[
\begin{align*}
\text{CH}_3&\text{C}=\text{CH} \\
&\text{CH}_2\text{CH}_2\text{CH}_3 \\
\end{align*}
\]

D) \[
\begin{align*}
\text{CH}_3&\text{C}=\text{C} \\
&\text{CH}_2\text{CH}_3 \\
\end{align*}
\]

E) \[
\begin{align*}
\text{CH}_2&\text{CH}=\text{CHCH}_2\text{CH}_3 \\
&\text{CH}_3 \\
\end{align*}
\]

2.) Which reaction of these potential acids and bases does not occur to any appreciable degree due to unfavorable equilibrium.

A) \[
\begin{align*}
\text{CH}_3\text{CH}_2\text{O}^- &+ \text{CH}_2=\text{CH}_2 \leftrightarrow \text{CH}_2=\text{CH} + \text{CH}_3\text{CH}_2\text{OH} \\
\text{CH}_2=\text{CH} &+ \text{CH}_3\text{CH}_2\text{OH} \\
\end{align*}
\]

B) \[
\begin{align*}
\text{NaOH} &+ \text{CH}_3\text{COH} \leftrightarrow \text{CH}_3\text{CONa}^+ + \text{H}_2\text{O} \\
\text{CH}_3\text{CONa}^+ &+ \text{H}_2\text{O} \\
\end{align*}
\]

C) \[
\begin{align*}
\text{CH}_3\text{Li} &+ \text{HC≡CH} \leftrightarrow \text{CH}_4 + \text{HC≡C}^-\text{Li}^+ \\
\text{CH}_4 &+ \text{HC≡C}^-\text{Li}^+ \\
\end{align*}
\]

D) \[
\begin{align*}
\text{NaNH}_2 &+ \text{CH}_3\text{CH}_2\text{OH} \leftrightarrow \text{CH}_3\text{CH}_2\text{O}^- + \text{NH}_3 \\
\text{CH}_3\text{CH}_2\text{O}^- &+ \text{NH}_3 \\
\end{align*}
\]

E) \[
\begin{align*}
\text{NaHCO}_3 &+ \text{H}_2\text{SO}_4 \leftrightarrow \text{NaHSO}_4 + \text{H}_2\text{CO}_3 \\
\text{NaHSO}_4 &+ \text{H}_2\text{CO}_3 \\
\end{align*}
\]
3.) Which of the following statements explains why the C=\text{C} double bond does not exhibit free rotation.
A) Substituents normally prefer to be eclipsed.
B) The C=\text{C} double bond is too short to rotate.
C) The Sp\textsuperscript{2} hybridized carbons can never rotate freely.
D) Rotation about the C=\text{C} double bond would force the alkene into a linear conformation.
E) Rotation would destroy the p orbital overlap.

4.) Which of the following best explains why 2-bromo-2-methylbutane is the major product in the reaction of 3-methyl-1-butene with HBr.
A) The reaction yields the anti-Markovnikov product.
B) The reaction yields the Markovnikov product.
C) The intermediate undergoes a carbocation rearrangement.
D) The reaction proceeds via anti-addition.
E) The reaction proceeds via syn addition.

5.) Which statement correctly describes the following reaction.
\[
\begin{array}{c}
\text{H} \\
\text{C=\text{C}}
\end{array} + \text{HCl} \rightarrow \text{CH}_3\text{CH}_2\text{Cl}
\]
A) This cannot be classified as an acid-base reaction.
B) The alkene acts as a Bronsted-Lowry acid
C) The alkene acts as a Lewis base but not a Bronsted-Lowry base
D) The alkene acts as both a Lewis base and Bronsted-Lowry base.
E) The HCl acts as both a Bronsted Lowry acid and Lewis base.

6.) Which statement about carbocations is FALSE?
A) The carbon that is (+) charged is Sp\textsuperscript{2} hybridized.
B) They can rearrange to form more stable carbocations.
C) They contain a vacant p\textsubscript{z} orbital
D) The more substituted carbocations are less stable than less substituted ones.
E) They react readily with Lewis bases and nucleophiles.

II(28). Complete each question as indicated.

1.) Draw the structure of E 3 t-butyl-4-propyl-2-heptene.
2.) Consider the following energy profile for the reaction of HBr with 2-methyl-1-propene.

![Energy Profile](image)

a) Which step (e.g. 1 → 2, 2 → 3, etc.) is the slowest.

b) What is the structure of the species indicated by 3.

c) The difference between what 2 points is the heat of the reaction (assuming entropy is negligible)

d) Is the overall reaction endothermic or exothermic- circle one.

3.) Complete the acid base reaction labeling acid, base, conjugate acid and conjugate base and determine which way the equilibrium is displaced.

\[
\text{CH}_3\text{CH}_2\text{C}≡\text{CH} + \text{CH}_3\text{O}^− \rightleftharpoons \text{CH}_3\text{CH}_2\text{C}≡\text{C}^− + \text{CH}_3\text{OH}
\]

4.) The following carbocation can rearrange in two different ways. Show each rearrangement and classify (1°, 2°, 3°) the original and newly formed carbocations.

\[
\text{CH}_3\quad + \quad \text{CH}_3\text{C}−\text{CH}−\text{CH}−\text{CH}_3
\]

5.) Show the structure of the intermediate and its stereochemistry when Br₂ adds to cis 3-hexene. Where does Br⁻ attack this intermediate and what products (show stereochemistry) are formed.
III(24) Answer both questions as indicated.

1.) Show the step by step mechanism of the hydroboration of 1-ethylcyclohexene with BH₃ in ether. Show the electron flow, transition state and stereochemistry of the product in this first stage.

2.) When the product formed in the above reaction is added to H₂O₂, what is the structure and stereochemistry of the new product.

3.) Show the step by step mechanism how H⁺/H₂O adds to the alkene indicated to give the two products shown.

\[
\begin{align*}
\text{CH} & \text{CH}_2 \quad + \quad \text{H}_2\text{O} \quad \xrightarrow{\text{H}^+} \\
\text{CH} & \text{CH}_3 \quad + \quad \text{CH}_2\text{CH}_3
\end{align*}
\]
4.) Discuss the relative heats of hydrogenation of cis- and trans-3-hexene and how this relates to the relative stability of the cis to trans isomer.

IV(24) Complete each reaction showing stereochemistry and labeling major/minor products when asked to.

1.) \[
\text{CH}_3\text{Br}_2 + \text{H}_2\text{O} \rightarrow \text{2 products- show stereochemistry}
\]

   one product contains oxygen, the other doesn't.

2.) \[
\text{CH}_3\text{CH}_2\text{C} = \text{CH} + \text{O}_3 \rightarrow \text{(CH}_3)_2\text{S} \rightarrow \text{2 products}
\]

3.) \[
\text{HBr} + \text{CCl}_4 \rightarrow \text{2 products; Label major}
\]

4.) \[
\text{Hg(OCCH}_3)_2 + \text{H}_2\text{O} \rightarrow \text{NaBH}_4
\]

5.) Cyclohexene + OsO\textsubscript{4} \[
\text{NaHSO}_3 \rightarrow \text{Show product in chair conformation}
\]