Practice Exam 3

Question 1

a) Circle the product that results when phenylmagnesium bromide reacts with water.

b) The compound eugenol, a major constituent in oil of clove, is pictured below. On the picture, circle the most acidic hydrogen atom.

c) Circle the major product that results when trans-2-butene is treated with acidic water.

d) Circle the product that results when cyclohexene reacts with hydrogen gas and palladium metal.
Question 2. Identify the missing reagents and/or major product(s) of the following reactions. In the small box, identify the reaction type (S_N2, S_N1, E2 or E1). Be sure to pay close attention to stereochemistry where appropriate.

a) 
\[
\begin{align*}
\text{Br} \quad \xrightarrow{\text{AgNO}_3, \text{CH}_3\text{OH}} & \quad \text{OCH}_3 \\
\text{product:} & \\
\text{reaction type:} & \text{S_N1} \\
\text{(E1 - minor)}
\end{align*}
\]

b) 
\[
\begin{align*}
\text{Cl} \quad \xrightarrow{\text{KO}_2\text{Bu}, \text{iBuOH}} & \quad \text{H}_3\text{C} = \text{CH}_3 \\
\text{reaction type:} & \text{E2}
\end{align*}
\]

c) 
\[
\begin{align*}
\text{OH} \quad \xrightarrow{\text{H}_2\text{SO}_4} & \quad \text{CH}_3 \\
\text{reaction type:} & \text{E1}
\end{align*}
\]
Question 3. (12 points) Consider a reaction with the following energy diagram.

![Energy Diagram](image)

**a)** Is the reaction endergonic or exergonic?

*endergonic*

**b)** If we assume that the reaction reaches equilibrium, what species (A, B, or C) will be in the highest concentration at the end of the reaction?

*A*

**c)** What species will be in the lowest concentration?

*B*

**d)** How might we design this reaction to convert A completely into C?

*If C is removed while it is formed, all of A will be converted to C*
Question 4. Starting from 1-methylcyclopentene, provide the missing reagents (in the boxes) for each of the following reactions. *Multiple steps may be needed.*

a)

1. BH$_3$
2. H$_2$O$_2$, NaOH

b)

H$_2$O$^+$

c)

D$_2$, Pd/C

d)

1. HBr
2. Mg, ether
3. D$_2$O
Question 5. a) In the box below, identify the product formed when deuterium-labeled 1-hexene is treated with dilute bromine in ethanol. *Make sure to consider stereochemistry.*

\[
\text{Br}_2, \text{EtOH} \quad \rightarrow \quad \text{Product}
\]

b) Provide a complete mechanism showing how your product in part (a) is formed. *Don’t skip any steps.* Make sure to clearly explain both the regiochemistry of your product (how & why each functional group becomes attached to a particular carbon atom in your product) and the stereochemistry of your product.

\[
\begin{align*}
&\text{Secondary carbon on the bromonium ion has larger } \delta^+ \text{ than the primary carbon} \\
&S_N2 \text{ ring opening of the bromonium ion proceeds with inversion of stereochemistry}
\end{align*}
\]
Question 6. Propose reagents that will accomplish the following transformation, and provide a complete mechanism. Even if you get stuck, proceed as far as you can for partial credit. It helps to analyze the problem both forwards and backwards.

\[
\begin{align*}
\text{HO} & \quad \text{CH}_3 \\
\text{HO} & \quad \text{CH}_3 \\
\text{HO} & \quad \text{CH}_3 \\
\end{align*}
\]
**Extra credit.** Provide a complete mechanism for the following reaction.