Selected Reactions of CHE 321-322
Question 1-5 are worth 3 points each. Questions 6-14 are worth 5 points each.

The following scheme illustrates a catalytic cycle for the hydrogenation of propene using a rhodium catalyst, Rh[P(C₆H₅)₃]₃Cl. The next three questions refer to this scheme.

1. Which of the labeled steps in the above catalytic cycle is an oxidative addition reaction? E
2. Which of the labeled steps in the above catalytic cycle is a reductive elimination reaction? D
3. Which of the rhodium complexes is a 14 electron complex?
   A. (I)   B. (II)   C. (III)   D. (IV)   E. (V)

Consider the following molecules.

(A)  (B)  (C)  (D)  (E)

4. Which of the above molecules is an enal? B
5. Which of the above molecules is a hemiacetal? D
6. Consider the following reaction scheme.

\[
\text{C}_6\text{H}_{12} \xrightarrow{\text{Br}_2} \xrightarrow{\text{LDA}} \text{S} \xrightarrow{\text{Pd(0), P(C}_6\text{H}_5)_3, \text{NEt}_3} \text{R}
\]

Predict the product \( \text{R} \).

(A) \[ \text{C}_6\text{H}_{11}\text{Br} \]

(B) \[ \text{C}_6\text{H}_{12} \]

(C) \[ \text{C}_6\text{H}_{12} \]

(D) \[ \text{C}_6\text{H}_{12} \]

(E) \[ \text{C}_6\text{H}_{12} \]

7. Consider the following reaction scheme.

\[
\text{C}_6\text{H}_{12} \xrightarrow{\text{Tf}_2\text{O}, \text{py}} \xrightarrow{\text{Pd(OAc)}_2, \text{P(C}_6\text{H}_5)_3, \text{NEt}_3} \text{Y}
\]

Predict the product \( \text{Y} \).

(A) \[ \text{C}_6\text{H}_{12} \]

(B) \[ \text{C}_6\text{H}_{12} \]

(C) \[ \text{C}_6\text{H}_{12} \]

(D) \[ \text{C}_6\text{H}_{12} \]

(E) \[ \text{C}_6\text{H}_{12} \]

8. The following compound was exposed to acid catalyzed deuterium exchange conditions. Predict the formula of the resulting compound.

\[
\text{C}_7\text{H}_{14} \xrightarrow{\text{D}^+ / \text{D}_2\text{O}} \text{X}
\]

(A) \[ \text{C}_7\text{H}_{13}\text{D}_1\text{O} \]

(B) \[ \text{C}_7\text{H}_{14}\text{D}_3\text{O} \]

(C) \[ \text{C}_7\text{H}_{14}\text{D}_4\text{O} \]

(D) \[ \text{C}_7\text{H}_{17}\text{D}_6\text{O} \]

(E) \[ \text{C}_7\text{H}_{17}\text{D}_7\text{O} \]
9. Carbonyl compounds can react with water to form a diol.

\[
\begin{align*}
\text{R}_1 \backslash \text{R}_2 & \quad \overset{\text{H}_2\text{O}}{\underset{\text{R}_1 \backslash \text{R}_2}{\longrightarrow}}
\end{align*}
\]

Which of the following compounds would be anticipated to have the largest equilibrium constant, \(K_{eq}\), for this hydration reaction?

- (A) \(\text{H}_3\text{C}-\text{CH}_2\text{OH}\)
- (B) \(\text{F}_3\text{C}-\text{CH}_2\text{OH}\)
- (C) \(\text{H}_3\text{C}-\text{CH}_3\)
- (D) \(\text{H}_3\text{C}-\text{CO}_2\text{CH}_3\)
- (E) \(\text{H}_3\text{C}-\text{CO}_2\text{CH}_3\)

10. A student was asked to write a mechanism for the following reaction.

\[
\begin{align*}
\text{O} + \text{HO}\text{-}\text{OH} \quad \overset{\text{H}^+/\text{H}_2\text{O}}{\longrightarrow} \quad \text{O}
\end{align*}
\]

Which of the following intermediates would be the least likely to be found in a correct mechanism?

- (A) \(\text{H}_3\text{C}-\text{O}^+\text{H}_2\text{O}\)
- (B) \(\text{CH}_3\text{OH}^{-}\)
- (C) \(\text{CH}_3\text{OH}^{-}\)
- (D) \(\text{CH}_3\text{C}^{\text{=O}}\text{CO}_2\text{H}\)
- (E) \(\text{CH}_3\text{C}^{\text{=O}}\text{CO}_2\text{H}\)

11. Predict the product, \(Z\), of the following reaction.

\[
\begin{align*}
\text{N} \quad \overset{\text{cat H}^+}{\underset{\text{Z}}{\longrightarrow}}
\end{align*}
\]

- (A) \(\text{N}\)
- (B) \(\text{N}\)
- (C) \(\text{C}^{\text{=O}}\text{CO}_2\text{N}\)
- (D) \(\text{C}^{\text{=O}}\text{CO}_2\text{N}\)
- (E) \(\text{O}\)
12. Aldehyde V was treated with base to give the product shown.

\[
\begin{align*}
V & \xrightarrow{\text{OH}^-, \text{H}_2\text{O}} \text{Product} \\
\end{align*}
\]

Which of the following aldehydes is compound V?

\[(A) \hspace{1cm} (B) \hspace{1cm} (C) \hspace{1cm} (D) \hspace{1cm} (E)\]

13. The following reaction sequence yields compound U.

\[
\text{H}^+ \xrightarrow{\text{PCC}} \text{(C}_6\text{H}_5\text{)}_3\text{P} \xrightarrow{\text{PhLi (excess)}} \text{H}^+/\text{H}_2\text{O} \xrightarrow{\text{(C}_6\text{H}_5\text{)}_3\text{P}=/} \text{U}
\]

Predict the structure of U.

\[(A) \hspace{1cm} (B) \hspace{1cm} (C) \hspace{1cm} (D) \hspace{1cm} (E)\]

14. The following reaction yields compound T predominately.

\[
\text{PhCH} = \text{O} \xrightarrow{\text{OH}^-, \text{H}_2\text{O}} \text{T}
\]

Predict the main product T.

\[(A) \hspace{1cm} (B) \hspace{1cm} (C) \hspace{1cm} (D) \hspace{1cm} (E)\]
15. Predict the product of the following reaction. (5 pts)

\[
\text{Li}^+ \quad \text{Cu}^2+ \rightarrow
\]

16. Predict the product of the following reaction. (5 pts)

\[
\text{O} + \text{O} \rightarrow \text{C}_9\text{H}_{10}\text{O}_2
\]

17. Predict the products, A, B, and C of the following synthetic roadmap. (10 pts)

18. The following reaction is one that you have not seen before. It is an epoxide synthesis known as the Darzens condensation. Write a curved arrow mechanism for the reaction. In a good mechanism all important intermediates should drawn separately. (10 pts)

Hint: Remove the most acidic hydrogen first.
Propose a synthesis of the following compound. All starting materials must be of four carbons or less.

(10 pts)

See the March 19 Problem of the Day discussion.