The mechanism of the Heck reaction is shown below. Use the diagram to answer the next four questions.

1. Which of the five labeled steps of the mechanism is an oxidative addition reaction? A

2. Which of the five labeled steps of the mechanism is a ligand insertion reaction? C

3. What is the electron count for Palladium compound (3)?
   A 14   B 15   C 16   D 17   E 18

4. What is the electron count for Palladium compound (4)?
   A 14   B 15   C 16   D 17   E 18

Consider the following structures

5. Which structure is an acetal? C

6. Which structure is an enol? E
Consider the following alkenes

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

7. Predict the major product of the following reaction sequence. B

\[
\text{Br} \quad \stackrel{\text{PPh}_3}{\longrightarrow} \quad \text{Li} \quad \stackrel{\text{O}}{\longrightarrow} \quad \text{CHO}
\]

8. Predict the major product of the following reaction sequence. C

\[
\text{Li} \quad \stackrel{\text{Cul}}{\longrightarrow} \quad \text{Br}
\]

---

Use the following compounds to answer the next two questions.

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

9. Predict the major product of the following reaction sequence. E

\[
\text{O} \quad \stackrel{\text{Li}}{\longrightarrow} \quad \text{H}^+
\]

10. Predict the major product of the following reaction sequence. A

\[
\text{O} \quad \stackrel{\text{Li}[\text{Cu}]}{\longrightarrow} \quad \text{H}^+
\]

11. Carbonyl compounds can form a hydrate as shown in the following equilibrium equation. Which of the compounds would be predicted to have the highest equilibrium constant for hydrate formation.

\[
\text{X} \quad \text{O} \quad \quad \text{X} \quad \text{HO} \quad \quad \text{OH} \quad \quad \text{Keq} = ?
\]

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

\[
\text{H}_3\text{C} \quad \text{O} \quad \text{CH}_3 \quad \text{H}_3\text{C} \quad \text{CH}_3 \quad \text{F}_3\text{C} \quad \text{CH}_3 \quad \text{F}_3\text{C} \quad \text{CF}_3 \quad \text{H}_3\text{C} \quad \text{N} \quad \text{CH}_3
\]
12. Predict the major product of the following reaction sequence.

\[
\text{HBr} \quad \text{Pd(PPh}_3\text{)}_4/\text{CuI/NEt}_3
\]

\[
\begin{align*}
\text{(A)} & \quad \text{(B)} & \quad \text{(C)} & \quad \text{(D)} & \quad \text{(E)} \\
\end{align*}
\]

13. The following aldehyde condenses to form an enal. Predict the structure.

\[
\begin{align*}
\text{(A)} & \quad \text{(B)} & \quad \text{(C)} & \quad \text{(D)} & \quad \text{(E)} \\
\end{align*}
\]

14. Predict the major product of the following reaction.

\[
\text{NaOH}
\]

\[
\begin{align*}
\text{(A)} & \quad \text{(B)} & \quad \text{(C)} & \quad \text{(D)} & \quad \text{(E)} \\
\end{align*}
\]
15. Compound (i) was treated with a catalytic amount of base. Predict the product mix.

\[
\begin{align*}
\text{(i)} & \quad \text{OH} \\
\end{align*}
\]

a. A mixture of (i) and (ii).
b. A mixture of (i) and (iii)
c. A mixture of (i) and (iv)
d. A mixture of (iii) and (iv)
e. A mixture of (i), (ii), (iii) and (iv)

16. The compound acrolein reacts with hydrazine via Michael Addition (1,4 conjugate addition) followed by an imine formation. Identify the product.

\[
\begin{align*}
\text{acrolein} + \text{H}_2\text{N}–\text{NH}_2 & \rightarrow \text{Michael Addition Product} \\
\text{imine} & \\
\end{align*}
\]

A) acrolein  B) hydrazine  C) Michael Addition Product  D) imine

17. Predict the product of the following Robinson Annulation reaction. (6 pts)

\[
\begin{align*}
\text{C}_7\text{H}_9\text{NO} + \text{C}_4\text{H}_6\text{O} & \rightarrow \text{C}_{11}\text{H}_{13}\text{NO} \\
\end{align*}
\]
18. Show how you could carry out the following transformation. More than one step may be required. (6 pts)

\[
\begin{align*}
\text{O} & \xrightarrow{\text{HO-}} \text{OH} \xrightarrow{\text{LiAlH}_4} \xrightarrow{\text{H}^+} \text{O} \\
\text{C}_6\text{H}_{12}\text{O}_2 & \xrightarrow{\text{H}^+} \text{C}_6\text{H}_{12}\text{O}_2
\end{align*}
\]

19. When the compound cyclohex-3-enone is treated with a catalytic amount of HCl the compound isomerizes to cyclohex-2-enone. Draw a curved arrow mechanism for this transformation. (8 pts)

\[
\begin{align*}
\text{O} & \xrightarrow{\text{H-Cl}} \text{O} \\
\text{C}_6\text{H}_{10} & \xrightarrow{\text{H-Cl}} \text{C}_6\text{H}_{10}
\end{align*}
\]

cyclohex-3-enone
cyclohex-2-enone

20. Draw a mechanism and predict the product of the following transformation. (10 pts)

\[
\begin{align*}
\text{C}_{10}\text{H}_{16}\text{O}_2 & \xrightarrow{\text{OH}} \text{C}_{10}\text{H}_{16}\text{O}_2 \\
\text{C}_{10}\text{H}_{16} & \xrightarrow{\text{OH}} \text{C}_{10}\text{H}_{16}
\end{align*}
\]

21. Give a synthesis of the following compound. All starting materials must be of four carbons or less. (10 pts)

\[
\begin{align*}
\text{Cyclic compound} & \xrightarrow{\text{OH}} \text{Cyclic compound} \\
\text{Cyclic compound} & \xrightarrow{\text{OH}} \text{Cyclic compound}
\end{align*}
\]

There are many possible syntheses. Visit the Problem of the Day Discussion for March 18 and post yours.