Multiple Choice Questions. 60 points Select the best answer to each of the questions.

1. In the following separation choose the answer that has the compounds correctly located.

   ![Diagram]

   A. hydrocarbon = 1
       amine = 3
       acid = 5
   B. hydrocarbon = 3
       amine = 1
       acid = 4
   C. hydrocarbon = 3
       amine = 4
       acid = 1
   D. hydrocarbon = 2
       amine = 1
       acid = 4
   E. hydrocarbon = 2
       amine = 3
       acid = 5

2. Choose the reaction type that corresponds to the inhibition of COX by aspirin.

   ![Chemical reactions A, B, C, D]

3. Arrange the following carbonyl groups in order of increasing reactivity towards $\text{OH}$ in $\text{H}_2\text{O}$.

   ![Carbonyl groups i, ii, iii]

   i < ii < iii
4. Choose the structure least likely to be an intermediate in the acid catalyzed hydrolysis of benzamide.

\[
\text{H}^+ + \text{Ph-} \begin{array}{c} \text{C} \\ \text{N} \end{array} \xrightarrow{\text{H}_2\text{O}} \text{Ph-} \begin{array}{c} \text{C} \\ \text{O} \end{array} + \text{H-N-H}
\]

A  B  C  D  E

5. Predict the product of the following reaction.

\[
\text{H}_2\text{C=O} + \text{O} \begin{array}{c} \text{C} \\ \text{O} \end{array} \xrightarrow{(\text{CH}_3)_2\text{NH}} \text{HCl} \]

\[
\text{Mannich Reaction}
\]

A  B  C  D  E

6. Predict the product of the following reaction.

\[
\begin{array}{c} \text{CH}_3 \text{O} \\ \text{CH}_3 \text{O} \\ \text{CH}_3 \text{O} \end{array} \xrightarrow{1. \text{OH}} \xrightarrow{2. \text{H}_2\text{O}} \xrightarrow{3. \text{Heat, 100}^\circ} \]

A  B  C  D  E
7. Predict the product of the following reaction.

\[
\text{O} \quad \text{O} \quad \text{CH}_3 \\
\text{O} \quad \text{O} \quad \text{CH}_3 \quad \text{heat} \\
\text{O} \quad \text{O} \quad \text{CH}_3
\]

A B C D E

8. Predict the product of the following reaction.

\[
\text{Ph} \quad \text{O} \quad \text{O} \quad \text{CH}_3 \\
\text{O} \quad \text{O} \quad \text{CH}_3 \quad \text{Ph} \quad \text{O} \quad \text{O} \quad \text{CH}_3
\]

A B C D E

9. Choose the major product of the following reaction.

\[
\text{O} \quad \text{N}_3 \\
\text{O} \quad \text{CH}_3 \quad \text{heat} \\
\text{O} \quad \text{OH} \quad \text{O} \quad \text{NH}_2 \quad \text{NH}_2 \quad \text{NH}_2 \quad \text{NH}_2 \quad \text{NH}_2 \quad \text{NH}_2
\]

A B C D E
10. Choose the species that is an intermediate in the following reaction.

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O} \\
\text{H}_3\text{C} & \quad \text{O} \\
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O}
\end{align*}
\]

1. OCH\text{H}_3

2. H\text{O}

A  B  C  D  E

11. Choose the most basic atom.

\[
\begin{align*}
\text{A} & \quad \text{O} \\
\text{H} & \quad \text{N} \\
\text{B} & \quad \text{N} \\
\text{C} & \quad \text{B} \\
\text{D} & \quad \text{D}
\end{align*}
\]

12. Choose the reaction that would not give the amine shown below.

\[
\begin{align*}
\text{A} & \quad \text{NH}_2 \\
\text{C} & \quad \text{H} \\
\text{E} & \quad \text{Br}
\end{align*}
\]

\[
\begin{align*}
\text{1. LiAlH}_4 & \quad 1. \text{NH}_3 \\
\text{2. H}_2\text{O} & \quad 2. \text{NaBH}_3\text{CN} \\
\text{1. Mg} & \quad 1. \text{CN} \\
\text{2. NH}_3 & \quad 2. \text{LiAlH}_4
\end{align*}
\]
13. The following is a description for the preparation of L-B films, a method for the production of layers on a glass surface.

1. A solution with bipolar molecules (for example, soap molecules) is created so that the bipolar molecules form a close packed layer on the surface. This condition is maintained during the following two steps.

2. A glass plate (hydrophilic surface) is pushed into the solution.

3. The glass plate is then withdrawn from the solution.

Using the symbol for a bipolar molecule shown below, sketch the organization of the bipolar molecules on the surface of the glass that compose the L-B film. 5 pts

A bilayer of bipolar molecules (soap) forms on the surface.
14. Propose a good synthesis of the following compound. 5 pts

\[
\begin{align*}
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl}
\end{align*}
\]

\[
\text{H}_3\text{PO}_2, \text{H}_2\text{O} \quad \text{Cl} & \quad \text{N}_2 \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl}
\]

\[
\text{NaNO}_2, \text{HCl} \quad 0 - 5 \degree \text{C} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl}
\]

\[
\text{FeCl}_3/\text{Cl}_2 \\
\text{NH}_2 \\
\text{Fe}/\text{HCl} \\
1) \quad \text{Fe}/\text{HCl} \\
2) \quad \text{NaOH}
\]

15. The treatment of farnesol with \( \text{H}_2\text{SO}_4 \) gives bisabolene. Using the curved arrow formalism show a good reaction mechanism for this transformation. 10 pts

\[
\begin{align*}
\text{farnesol} & \quad \text{bisabolene} \\
\text{OH} & \quad \text{OH} \\
\text{OH}_2 & \quad \text{H}_2\text{O}
\end{align*}
\]

\[
\text{farnesol} \\
\text{OH} \\
\text{OH}_2 \\
\text{-H}_2\text{O}
\]

\[
\text{bisabolene} \\
\text{OH} \\
\text{OH}_2 \\
\text{OH}_3
\]

\[
\text{bisabolene} \\
\text{OH} \\
\text{OH}_2 \\
\text{OH}_3
\]

\[
\text{bisabolene} \\
\text{OH} \\
\text{OH}_2 \\
\text{OH}_3
\]
16. Using the curved arrow formalism show the bond making and breaking in the following transformation. 10 pts

\[ \text{O} \quad \text{N} \quad \text{H} \quad \text{+ heat} \quad \text{N}_2 \]

\[ \text{O} \quad \text{C} \quad 
\]

\[ \text{a carbene analogous to the nitrene of the Curtius rearrangement} \]

17. A synthesis of Fentanyl, a powerful analgesic, involved the following steps. Provide structures for compounds A-D. 10 pts

\[ \text{A} \quad \text{B} \quad \text{C} \quad \text{D} \]

\[ \text{A} \quad \text{B} \quad \text{C} \quad \text{D} \]