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.

   ![Chemical structures](image)

   - 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.

   - A
   - B
   - C
   - D
   - E

3. Arrange the following carbonyl groups in order of increasing reactivity towards $\cdot$OH in H2O.

   - A increasing reactivity
   - B increasing reactivity
   - C increasing reactivity
   - D increasing reactivity
   - E increasing reactivity
4. Choose the structure least likely to be an intermediate in the acid catalyzed hydrolysis of benzamide.

\[
\begin{align*}
\text{H}^+ + & \text{Ph} - \text{C} = \text{N}^\text{H} \xrightarrow{\text{H}_2\text{O}} \text{Ph} - \text{C} = \text{O}^\text{H} + \text{H}^+ - \text{N} - \text{H} \\
\text{A} & \text{B} \quad \text{C} \quad \text{D} \quad \text{E}
\end{align*}
\]

5. Predict the product of the following reaction.

\[
\text{H}_2\text{C} = \text{O} + \text{CH}_3\text{O} - \text{C} = \text{O} \xrightarrow{\text{(CH}_3\text{)}_2\text{NH} \ \text{HCl}} ?
\]

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

6. Predict the product of the following reaction.

\[
\begin{align*}
\text{CH}_3\text{O} - \text{C} = \text{O} - \text{C} = \text{O} - \text{O} - \text{C} = \text{O} \xrightarrow{1. \text{OH}} \xrightarrow{2. \text{H}_2\text{O}^\text{H}} \xrightarrow{3. \text{Heat, } 100^\circ} \\
\text{A} & \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E}
\end{align*}
\]
7. Predict the product of the following reaction.

\[
\text{CH}_3\text{O} \xrightarrow{\text{heat}} \text{Claisen rearrangement}
\]

8. Predict the product of the following reaction.

\[
\text{Ph} \xrightarrow{\text{O} \rightarrow \text{CH}_3} \text{?}
\]

9. Choose the major product of the following reaction.

\[
\text{CH}_3\text{OH} \xrightarrow{\text{heat}} \text{?}
\]
10. Choose the species that is an intermediate in the following reaction.

\[
\begin{align*}
&\text{A} \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E} \\
&\text{O} \quad \text{O} \quad \text{O} \quad \text{O} \quad \text{O} \\
&\text{CH}_3 \quad \text{O} \quad \text{O} \quad \text{O} \quad \text{O} \\
&1. \text{O} \rightarrow \text{CH}_3 \quad 2. \text{H}_2\text{O}
\end{align*}
\]

11. Choose the most basic atom.

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

\[
\begin{align*}
&? \quad ? \\
&\text{A} \quad \text{B} \quad \text{C} \quad \text{D} \\
&\text{NH}_2 \\
&1. \text{LiAlH}_4 \\
&2. \text{H}_2\text{O} \\
&1. \text{NH}_3 \\
&2. \text{NaBH}_3\text{CN} \\
&1. \text{CN} \\
&2. \text{LiAlH}_4 \\
\end{align*}
\]
Short Answer Questions. 40 points.

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

14. Propose a good synthesis of the following compound. 5 pts

15. The treatment of farnesol with H₂SO₄ gives bisabolene. Using the curved arrow formalism show a good reaction mechanism for this transformation. 10 pts
16. Using the curved arrow formalism show the bond making and breaking in the following transformation. 10 pts

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