Multiple Choice Questions: 50 points

1. Select the major product of the following reaction.

\[ \text{H}^+ \]

\[ \begin{array}{c}
\text{A} \\
\text{B} \\
\text{C} \\
\text{D} \\
\text{E} \\
\text{F}
\end{array} \]

2. The following mechanistic step is part of a reaction you will soon learn, known as a retro-aldol reaction. Based on the following curved arrows, select the correct corresponding intermediate formed.

\[ \begin{array}{c}
\text{A} \\
\text{B} \\
\text{C} \\
\text{D} \\
\text{E}
\end{array} \]

3. Choose the reactant(s) that could successfully fill in the blank in the following synthesis.

\[ \begin{array}{c}
\text{A} \quad \text{i} \\
\text{B} \quad \text{ii} \\
\text{C} \quad \text{iii} \\
\text{D} \quad \text{i + ii} \\
\text{E} \quad \text{i + iii} \\
\text{F} \quad \text{ii + iii}
\end{array} \]
4. Select the intermediate that is least likely formed during the course of the second reaction of the following synthesis of acetone.

5. Choose the major product of the following reaction sequence.

6. Choose the worst method to synthesize ethyl acetate, from the ones shown below.
7. Choose the order that has the following enols correctly arranged with respect to increasing stability.

\[ \text{CHOH} \quad \text{CHOH} \quad \text{CHO} \]

\( i \quad ii \quad iii \)

\[ \text{CHOH} \quad \text{CHOH} \quad \text{CHO} \]

\( i \quad iii \quad ii \)

\[ \text{CHOH} \quad \text{CHOH} \quad \text{CHO} \]

\( ii \quad i \quad iii \)

\[ \text{CHOH} \quad \text{CHOH} \quad \text{CHO} \]

\( iii \quad ii \quad i \)

\[ \text{CHOH} \quad \text{CHOH} \quad \text{CHO} \]

\( iii \quad i \quad ii \)

A: increasing stability  B: increasing stability  C: increasing stability  D: increasing stability  E: increasing stability  F: increasing stability

8. Select the major product of the following reaction between butanal and hydrazine under acidic conditions.

\[ \text{H}_2\text{N} \equiv \text{NH}_2 \quad \text{H}^+ \quad \text{H}_2\text{N} \equiv \text{NH}_2 \]

\[ \text{HC} = \text{O} \]

9. Select the order that has the following carbonyl compounds correctly arranged with respect to increasing reactivity with lithium aluminum hydride.

\[ \text{CHO} \quad \text{CHOCH}_3 \quad \text{COCH}_3 \]

\( i \quad ii \quad iii \)

\[ \text{CHO} \quad \text{CHOCH}_3 \quad \text{COCH}_3 \]

\( ii \quad i \quad iii \)

\[ \text{CHO} \quad \text{CHOCH}_3 \quad \text{COCH}_3 \]

\( iii \quad i \quad ii \)

\[ \text{CHO} \quad \text{CHOCH}_3 \quad \text{COCH}_3 \]

\( iii \quad ii \quad i \)

A: increasing reactivity  B: increasing reactivity  C: increasing reactivity  D: increasing reactivity  E: increasing reactivity  F: increasing reactivity

2 point partial credit for C
10. Glucose is a monosaccharide, with open chain and cyclic isomeric structures. The hemiacetal cyclic structure predominates in equilibrium. Select the correct open chain structure for the radiolabeled (with oxygen-18) D-glucose structure shown below.

\[ \text{?} \xrightarrow{\text{equilibrium}} \text{Hemiacetal structure} \]

\[ \begin{align*}
\text{A} & : \text{HO}^{18} \quad \text{OH} \quad \text{OH} \\
\text{B} & : \text{HO} \quad \text{OH}^{18} \quad \text{OH} \\
\text{C} & : \text{HO} \quad \text{OH} \quad \text{O}^{18} \\
\text{D} & : \text{HO}^{18} \quad \text{OH} \quad \text{OH} \\
\text{E} & : \text{HO} \quad \text{OH} \quad \text{O}^{18} \\
\text{F} & : \text{HO} \quad \text{OH}^{18} \quad \text{OH}
\end{align*} \]

**Short Answer Questions: 50 points**

11. Give the structure of the major product of the following reaction sequence. 5 pts

\[ \text{HO} \quad \text{OH} \quad \text{OH} \xrightarrow{\text{H}_2\text{CrO}_4, \text{H}_2\text{O}} \text{heat, acetone} \xrightarrow{\text{HO}^+} \text{HO}^+ \quad \text{C}^0 \quad \text{HO}^- \]

12. Give the structure of the major product of the following reaction sequence. 5 pts

\[ \text{HCN} \quad \xrightarrow{1. \text{LiAlH}_4} \quad \text{HO} \quad \text{NH}_2 \]

\[ \text{HO} \quad \text{NH}_2 \]
13. Give the structure of the major product of the following reaction. 5 pts

\[
\text{Ph}_3\text{P} = \text{CH}_2 \quad \rightarrow \quad \text{C}_{10}\text{H}_{18}\text{O}
\]

14. Give the structure of the major product of the following reaction sequence. 5 pts

\[
\text{C}_{6}\text{H}_{10}\text{O}_3 \quad \xrightarrow{\text{LDA, -78 }^\circ \text{C}} \quad \xrightarrow{1. \text{CH}_3\text{Br}} \quad \xrightarrow{2. \text{H}_3\text{O}^+} \quad \text{CH}_3 \quad \text{CH}_3
\]

15. Reaction of compound A with ethylene glycol under acidic conditions leads to compound B. Treatment of A with aqueous base, followed by acidification and heat gives butanone. Reaction of compound X (C₆H₁₀O₃) with sodium ethoxide, followed by methyl bromide gives compound A. Clearly draw the structures of compounds A and B. 10 pts

\[
\xrightarrow{1. \text{OH}^-} \quad \xrightarrow{2. \text{H}^+} \quad \xrightarrow{3. \text{heat}} \quad \text{A} \quad \xrightarrow{\text{H}^+} \quad \text{B} \quad \xrightarrow{1. \text{NaOEt}} \quad \xrightarrow{2. \text{CH}_3\text{Br}} \quad \text{X} \quad \text{C}_6\text{H}_{10}\text{O}_3
\]
16. Using the curved arrow formalism, show all the bond making and bond breaking steps of the following reaction sequence. 10 pts

17. Propose a synthesis of the following compound starting from any compounds containing four carbon atoms or less. 10 pts