Rank the following species in **decreasing** order of reactivity toward addition of a nucleophile to the most electrophilic \( \text{sp}^2 \) hybridized carbon. (Most > Least).

A) 3 > 1 > 2  
B) 2 > 3 > 1  
C) 1 > 2 > 3  
D) 2 > 1 > 3  
E) 1 > 3 > 2

What is the major organic product obtained from the following reaction?

A) 1  
B) 2  
C) 3  
D) 4

1. What is the product A that would be obtained from the following reaction sequence?

A) I  
B) II  
C) III  
D) IV

Rank the following molecules in the order of **decreasing** favorability of hydration. (Most > Least)

A) 3 > 1 > 2  
B) 2 > 1 > 3  
C) 1 > 2 > 3  
D) 2 > 3 > 1  
E) 1 > 3 > 2
Rank these compounds in order of decreasing activity in electrophilic substitution? (fastest > slowest)

A) II > IV > I > III  
B) I > III > IV > II  
C) IV > II > I > III  
D) III > I > II > IV  
E) IV > I > II > III

Which of the following is the reactive intermediate formed in the electrophilic nitration of nitrobenzene with HNO₃ and H₂SO₄?

A) 1  
B) 2  
C) 3  
D) 4

In the following molecule, which hydrogen atom is most susceptible to abstraction by free radicals?

A) I  
B) II  
C) III  
D) IV  
E) V

What is the highest occupied molecular orbital (HOMO) for 1,3-butadiene?

A) I  
B) II  
C) III  
D) IV
Which amines could be made by a Gabriel synthesis (Phthalimide, KOH, followed by H₂NNH₂)?

A) I only  
B) II only  
C) III only  
D) I and II only  
E) II and III only

Lysine, an amino acid, has three acidic hydrogen atoms (a₁, a₂, a₃ below). What major species would be observed in an aqueous solution at pH = 7? The pKₐ values are pKₐ₁ of COOH = 2.2, pKₐ₂ of NH₃⁺ = 9.0, and pKₐ₃ of NH₃⁺ = 10.8.

A) III  
B) IV  
C) II  
D) I  
E) None of the above

Assuming gas phase conditions, rank compounds in order of strongest to weakest base. (Stronger > Weaker)

<table>
<thead>
<tr>
<th>Conjugate Acid</th>
<th>pKₐ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.3</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>4.6</td>
</tr>
<tr>
<td>4</td>
<td>10.7</td>
</tr>
</tbody>
</table>

A) 3 > 1 > 4 > 2  
B) 2 > 3 > 1 > 4  
C) 4 > 1 > 3 > 2  
D) 1 > 3 > 2 > 4  
E) 4 > 3 > 2 > 1
Which compound would be most stable?

A) A  
B) B  
C) C  
D) D

Some heterocyclic compounds can be Lewis bases (electron donors) and react with acidic hydrogens. Which of the following is not a base?  
(C = group IV and N = group V element)

A) I  
B) II  
C) III  
D) IV

18.) Rank the following compounds in order of increasing reactivity in electrophilic aromatic bromination. (slowest < fastest)

A) A < B < D < C

Place a letter in each box

9.) When 3-penten-2-one is exchanged in DO⁻/D₂O the resulting product is

A) I  
B) II  
C) III  
D) IV
What is the major organic product obtained from the following sequence of reactions?

1. LDA, -78 °C  
2. PhCO₂CH₃  
3. H₂O⁺  
4. LiAlH₄  
5. H₂O⁺

A) A  
B) B  
C) C  
D) D

The Claisen condensation of methyl butanoate produces

A) I  
B) II  
C) III  
D) IV

The reaction of cyclohexanone at elevated temperature and base concentration produces which of these self-condensation products?

A) III  
B) IV  
C) I  
D) V  
E) II
The product of the Aldol condensation of propanal (C₃H₆O) in base is the following.

A) A  
B) B  
C) C  
D) D

\[ \text{CH}_3\text{CH}_2\text{CO}_2\text{H} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CO}_2^- \text{NH}_4^+ \]

account for all atoms

1) Ph₃P  
2) C₆H₅Li  
3) CH₃CH₂CHO

15.

17. 2 points for Z isomer major

E isomer

12. two organic products

19.
What is the major organic product obtained from the following reaction?

A) (E)-3-methyl-2-pentene
B) (Z)-3-methyl-2-pentene
C) 2-methyl-2-pentene
D) 4-methyl-1-pentene
12.) Provide the reagents of the following reaction.

15.) Draw the major products at low temperature (25°C) and high temperature (90°C)
14.  
\[
\text{O} + \text{CHOH} \quad \xrightarrow{\text{NaOH, H}_2\text{O}} \quad \text{NaOH, H}_2\text{O} \\
\text{100°C} \quad \xrightarrow{2 \text{ reactants}} \quad \text{O}
\]

19.  
\[
\begin{align*}
&\text{Benzene} \\
&\text{H}_2\text{SO}_4 \\
&5-10°C \\
\end{align*}
\]

14.  
\[
\begin{align*}
&\text{Cl} \\
&\xrightarrow{1.) \ DIBAL-H} \\
&\xrightarrow{2.) \ \text{H}_2\text{O or H}_3\text{O}^+} \\
&\text{Cl} \\
\end{align*}
\]

or
\[
\begin{align*}
&\text{Cl} \\
&\xrightarrow{1.) \ Li\text{AlH(t-BuO)}_3} \\
&\xrightarrow{2.) \ \text{H}_2\text{O or H}_3\text{O}^+} \\
&\text{Cl}
\end{align*}
\]