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

1. In the following separation choose the location of the carboxylic acid.

![Chemical structures and reactions]

A. 

B. 

C. 

D. 

E. 

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**Answer:**

*Your answer here*
2. Choose the order that has the following compounds correctly arranged with respect to increasing basicity.

\[
\begin{align*}
\text{i} & \quad \text{NH}_2 \quad \text{NH}_2 \quad \text{NH}_2 \\
\text{ii} & \quad \text{NO}_2 \\
\text{iii} & \quad \text{SEM} \\
\end{align*}
\]

\[
\begin{align*}
i < ii < iii & \quad \text{increasing basicity} \\
i < iii < ii & \quad \text{increasing basicity} \\
ii < iii < i & \quad \text{increasing basicity} \\
ii < i < iii & \quad \text{increasing basicity} \\
iii < i < ii & \quad \text{increasing basicity} \\
\end{align*}
\]

A. \(i\)  
B. \(ii\)  
C. \(iii\)  
D. \(i\) and \(ii\)  
E. \(ii\) and \(iii\)

3. Choose the reaction(s) that would not give aniline.

\[
\begin{align*}
\text{i} & \quad \text{cyclohexene} & \quad 1. \text{LiAlH}_4 \quad \text{2. H}_2\text{O} \quad \text{aniline} \\
\text{ii} & \quad \text{benzonitrile} & \quad \text{heat} \quad \text{H}_2\text{O} \quad \text{aniline} \\
\text{iii} & \quad \text{acetylacetone} & \quad 1. \text{LiAlH}_4 \quad \text{2. H}_2\text{O} \quad \text{aniline} \\
\end{align*}
\]

A. \(i\)  
B. \(ii\)  
C. \(iii\)  
D. \(i\) and \(ii\)  
E. \(ii\) and \(iii\)

4. Using benzene as the reactant, choose the reaction(s) that would not give \(m\)-chlorobromobenzene.

\[
\begin{align*}
\text{i} & \quad \text{benzene} & \quad 1. \text{Cl}_2/\text{FeCl}_3 \quad 2. \text{Br}_2/\text{FeBr}_3 \quad \text{BrCl} \\
\text{ii} & \quad \text{benzene} & \quad 1. \text{HNO}_3/\text{H}_2\text{SO}_4 \quad 2. \text{Cl}_2/\text{FeCl}_3 \quad 3. \text{Br}_2/\text{FeBr}_3 \quad 4. \text{H}_2/\text{Pd} \quad 5. \text{NaNO}_2/H^+/0^\circ \quad 6. \text{H}_3\text{PO}_2 \quad \text{BrCl} \\
\text{iii} & \quad \text{benzene} & \quad 1. \text{HNO}_3/\text{H}_2\text{SO}_4 \quad 2. \text{Cl}_2/\text{FeCl}_3 \quad 3. \text{H}_2/\text{Pd} \quad 4. \text{CuBr}/100^\circ \quad \text{BrCl} \\
\end{align*}
\]

A. \(i\)  
B. \(ii\)  
C. \(iii\)  
D. \(i\) and \(ii\)  
E. \(ii\) and \(iii\)

5. Choose the order that has the following carbonyl groups correctly arranged with respect to increasing resonance stabilization.

\[
\begin{align*}
\text{i} & \quad \text{H}_3\text{C}^\text{C}=\text{S}^\text{CH}_3 \\
\text{ii} & \quad \text{H}_3\text{C}^\text{C}=\text{N}^\text{CH}_3 \\
\text{iii} & \quad \text{H}_3\text{C}^\text{C}=\text{O}^\text{CH}_3 \\
\end{align*}
\]

\[
\begin{align*}
i < ii < iii & \quad \text{increasing stability} \\
i < iii < ii & \quad \text{increasing stability} \\
ii < iii < i & \quad \text{increasing stability} \\
ii < i < iii & \quad \text{increasing stability} \\
iii < i < ii & \quad \text{increasing stability} \\
\end{align*}
\]

A. \(i\)  
B. \(ii\)  
C. \(iii\)  
D. \(i\) and \(ii\)  
E. \(ii\) and \(iii\)
6. Choose those structures consistent with the isoprene rule. That is, which structures have identifiable isoprene units.

A. i
B. ii
C. iii
D. i and iii
E. ii and iii

7. Choose the most reasonable cation as a structure for an intermediate in the biosynthesis of limonene from geraniol.

8. Choose the reaction type that you would not anticipate for NADPH.

A. i
B. ii
C. iii
D. i and iii
E. ii and iii

9. Choose the major product of the following reaction.
10. Choose the electron count for the metal in following transition metal complex.

\[
\text{RC}_{6}H_{5}P\text{Rh}P(\text{C}_{6}H_{5})_{3} \quad \begin{array}{c} A = 14 \\ B = 15 \\ C = 16 \\ D = 17 \\ E = 18 \end{array}
\]

11. Choose the major product of the following reaction.

\[
\text{Ru} \quad \text{olefin metathesis}
\]

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

\[
\text{AlCl}_{3} \quad \text{CH}_{3}\text{CO}_{2}\text{H}
\]

Short Answer Questions. 40 points.

13. Give the structure the major product of the following reactions.

(a) \[
\text{BrPh} + \text{Pd}^{+} \quad \text{BrPh}
\]

(b) \[
\text{BrPh} \quad \text{C}_{13}\text{H}_{14}\text{O} + \text{CO}_{2} \quad \text{Br}^{	ext{-}}
\]
14. Give the reactants and reagents that could be used to perform the following transformation.

(a) 

(b) and any other compounds containing 4 carbon atoms or less

15. Give the structures for compounds A-D.

16. Using the curved arrow formalism show how the isomerism of isopentenyl pyrophosphate to dimethylallyl pyrophosphate can occur and their reaction to give geranyl pyrophosphate in the biosynthesis of cholesterol.