Sample exam questions for First exam – CHM 2211

1. The IR absorption due to the stretching of which of these carbon-hydrogen bonds occurs at the highest frequency?

\[ \text{I} \quad \text{II} \quad \text{III} \]

\[ \text{IV} \quad \text{V} \]

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

2. How many signals would you expect to find in the $^1$H NMR spectrum of CH$_3$OCH$_2$CH$_2$OCH$_3$?

A) 1 
B) 2 
C) 3 
D) 4 
E) 5

3. Which proton(s) of the compound below would appear as a triplet in the $^1$H NMR spectrum?

\[ \text{CH}_3\text{CH}_2\text{CH}_2\text{O-CH} \]

\[ \uparrow \uparrow \uparrow \uparrow \text{CH}_3 \]

A) The protons on carbon II  
B) The protons on carbon I and V  
C) The protons on carbon III and V  
D) The protons on carbon III and IV  
E) The protons on carbon V
4. A compound with the molecular formula C₆H₁₅N gave the following ¹H NMR spectrum:

- triplet, δ 0.90
- quartet, δ 2.4

There were no other signals. The most likely structure for the compound is:

A) \( \text{CH}_3 \text{NCH}_2 \text{CH}_3 \)
\[ \text{CH}_2 \text{CH}_2 \text{CH}_3 \]
B) \( \text{CH}_3 \text{NCH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_3 \)
\[ \text{CH}_3 \]
C) \( \text{CH}_3 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{NH}_2 \)
D) \( \text{CH}_3 \text{CH}_2 \text{NCH}_2 \text{CH}_3 \)
\[ \text{CH}_2 \text{CH}_3 \]
E) \( \text{CH}_3 \text{CH}_2 \text{CH}_2 \text{NCH}_2 \text{CH}_2 \text{CH}_3 \)

5. How many \(^{13}\text{C}\) signals would 1,2-dimethylbenzene give?

\[ \text{C}_6\text{H}_5 \]
A) 1
B) 2
C) 3
D) 4
E) 5

6. The data below from the molecular ion region of the mass spectrum of a halogen-containing compound are consistent with the presence of what halogen(s) in the original compound?

<table>
<thead>
<tr>
<th>intensity</th>
<th>( \text{M}^+ )</th>
<th>( \text{M}^+. +2 )</th>
<th>( \text{M}^+. +4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.0</td>
<td>100.0</td>
<td>49.0</td>
<td></td>
</tr>
</tbody>
</table>

A) One Br
B) One Cl
C) One Br and one Cl
D) Two Br
E) Two Cl
7. Which of the following resonance structures is not a significant contributor to the hybrid for the carbonyl group?

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

- I
- II
- III

A) I
B) II
C) III
D) Neither II nor III is important.
E) All are significant contributors.

8. CrO$_3$ in H$_2$SO$_4$/H$_2$O will fail to give a positive test with which of these compounds?

A) CH$_3$CH$_2$CH$_2$CH$_2$OH
B) CH$_3$CH$_2$CH$_2$CH$_3$
C) (CH$_3$)$_3$COH
D) CH$_3$CH$_2$C\(=\)O
E) More than one of these
9. The final product, D, in the following reaction sequence, would be?

\[
\begin{align*}
\text{CH}_3\text{CHOH} & \xrightarrow{\text{PBr}_3} \text{A} & \xrightarrow{\text{Mg, ether}} & \text{B} & \xrightarrow{\text{H}_3\text{O}^+} & \text{D} \\
\text{CH}_3 & \\
\end{align*}
\]

A) \(\text{CH}_3\text{CHOCH}_2\text{CH}_2\text{OH}\)
B) \(\text{CH}_3\text{CHCH}_2\text{CH}_2\text{Br}\)
C) \(\text{CH}_3\text{CHCH}_2\text{CH}_2\text{OH}\)
D) \(\text{CH}_3\text{CHOCH}_2\text{CH}_3\)
E) \(\text{CH}_3\text{CHCH}_2\text{CH}_3\)

10. What is the final product of the following reaction sequence?

\[
\begin{align*}
\text{CH}_3\text{I} & \xrightarrow{\text{Mg, Et}_2\text{O}} \xrightarrow{i) \text{CH}_2=\text{CH}_2} \xrightarrow{ii) \text{H}_3\text{O}^+} \text{A} \\
\text{I} & \xrightarrow{\text{II}} \xrightarrow{\text{III}} \\
\text{IV} & \xrightarrow{\text{V}} \\
\end{align*}
\]

A) I
B) II
C) III
D) IV
E) V
11. What would be the product, A, of the following reaction?

\[
\text{\begin{raw}{c}
\begin{array}{c}
\text{O} \\
\text{Na} \\
\text{D}
\end{array}
\end{raw}} \quad \text{A}
\]

i) NaBD\textsubscript{4}  
ii) H\textsubscript{2}O

A)  
B)  
C)  
D)  
E)  

12. Which of the reagents listed below would efficiently accomplish the transformation of 3-methyl-3-cyclopentenone into 3-methyl-3-cyclopentenol?

\[
\text{\begin{raw}{c}
\begin{array}{c}
\text{O} \\
? \\
\text{OH}
\end{array}
\end{raw}} \quad \text{OH}
\]

A)  i) LiAlH\textsubscript{4}; ii) H\textsubscript{2}O  
B)  NaBH\textsubscript{4},H\textsubscript{2}O  
C)  H\textsubscript{2}, Pd  
D)  A) and B)  
E)  A), B) and C) of the above

13. Your task is to synthesize \( \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3\text{CCH}_3\text{C}_6\text{H}_5\text{OH} \) through a Grignard synthesis. Which pairs of compounds listed below would you choose as starting materials?

A) \( \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3\text{Br} \) and \( \text{CH}_3\text{C}_6\text{H}_5 \)
B) \( \text{CH}_3\text{CH}_2\text{CH}_2\text{CH} \) and \( \text{C}_6\text{H}_5\text{Br} \)
C) \( \text{C}_6\text{H}_5\text{CH} \) and \( \text{CH}_3\text{CH}_2\text{CHCH}_3 \)
D) More than one of these  
E) None of these
14. Select the correct reagent(s) for the following reaction:

\[ \text{CH}_3\text{CCH}_2\text{CH}_2\text{CO}_2\text{CH}_3 \rightarrow \text{OH} \]

A) Li\text{AlH}_4/\text{ether}; then \text{H}_3\text{O}^+
B) Na\text{BH}_4; then \text{H}_3\text{O}^+
C) \text{H}_2 \text{ with Pt/C}
D) A) and B)
E) A), B) and C)

15. What is an IUPAC name for this triene?

\[ \text{CH}_3\text{CH}_2\text{H}_\text{H}_\text{H}_\text{H}_\text{H}_\text{H} \]

A) (2E,4Z,6E)–2,4,6–Nonatriene
B) (2Z,4E,6Z)–2,4,6–Nonatriene
C) (2E,4Z,6Z)–2,4,6–Nonatriene
D) (3Z,5Z,7E)–3,5,7–Nonatriene
E) (3Z,5E,7E)–3,5,7–Nonatriene

16. Which of the following dienes would you expect to be the most stable?
A) \text{CH}_3\text{CH}_2\text{CH}==\text{CHCH}_2\text{CH}=\text{CHCH}_3
B) \text{CH}_3\text{CH}==\text{CHCH}==\text{CHCH}_2\text{CH}_3
C) \text{CH}_2==\text{CHCH}_2\text{CH}_2\text{CH}==\text{CH}_2
D) \text{CH}_2==\text{CHCH}==\text{CHCH}_2\text{CH}_2\text{CH}_3
E) \text{CH}_3\text{CH}_2\text{CH}==\text{C}=\text{CHCH}_2\text{CH}_3
17. Which is not an example of resonance?

I \[ \text{CH}_2=\text{CH}-\text{CH}_2 \cdot \leftrightarrow \cdot \text{CH}_2=\text{CH}=\text{CH}_2 \]

II \[ \text{CH}_2=\cdot \leftrightarrow \cdot \text{CH}_2 \]

III \[ \text{CH}_2=\cdot \leftrightarrow \cdot \text{CH}_3 \]

IV \[ \text{CH}_2=\cdot \leftrightarrow \cdot \text{CH}_2=\text{CH}_2\text{CCl}_3 \]

A) I  
B) II  
C) III  
D) IV  
E) None of these are examples of resonance

18. The accompanying diagram, which describes the fate of the intermediate in a reversible reaction, implies that:

![Reaction Coordinate Diagram]

A) the less stable product forms more rapidly.  
B) the more stable product forms more rapidly.  
C) product B will predominate at equilibrium.  
D) the intermediate has a short lifetime.  
E) No conclusions can be drawn as to either reaction rate or product stability.

19. Which of these dienes can undergo the Diels-Alder reaction?

A) 1,3-Pentadiene  
B) 1,4-Pentadiene  
C) 1,2-Butadiene  
D) 1,4-Cyclohexadiene  
E) All of the above can undergo the Diels-Alder reaction
20. What would be the product of the following reaction?

\[
\text{CH} = \text{CH} - \text{CHCH}_3 + \text{CH}_2 = \text{CHCH}_3 \xrightarrow{\text{heat}}
\]

\[
\begin{array}{cccc}
\text{I} & \text{II} & \text{III} & \text{IV} \\
\text{CH} = \text{CH} & \text{C} = \text{O} & \text{C} = \text{O} & \text{C} = \text{O} \\
\text{C} = \text{O} & \text{C} = \text{O} & \text{C} = \text{O} & \text{C} = \text{O} \\
\end{array}
\]

A) I  
B) II  
C) III  
D) IV  
E) All of these

21. Which diene and dienophile would you choose to synthesize the following compound?

\[
\text{CH}_2 = \text{CH} - \text{COCH}_3 \quad \text{and} \quad \text{O}_2
\]

\[
\begin{array}{ccc}
\text{I} & \text{II} & \\
\text{C} = \text{C} & \text{C} = \text{O} & \text{C} = \text{O} \\
\text{C} = \text{O} & \text{C} = \text{O} & \text{C} = \text{O} \\
\end{array}
\]

A) I  
B) II  
C) III  
D) IV  
E) None of these
22. Which of the following could be used to synthesize 3-bromocyclopentene?
   A) Cyclopentene + Br₂, CCl₄, 25°
   B) Cyclopentene + NBS, CCl₄ (ROOR)
   C) 3-Cyclopentenol + PBr₃
   D) Both A) and B)
   E) Both B) and C)

23. Which compound would have an UV absorption band at longest wavelength?

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

1. E
2. B
3. C
4. D
5. D
6. D
7. B
8. C
9. C
10. E
11. B
12. D
13. A
14. A
15. C
16. B
17. C
18. B
19. A
20. C
21. C
22. E
23. B