1. What is the IUPAC names for this compound?
   a) 1-tert-butyl-2-butanol
   b) 5,5-dimethyl-3-hexanol
   c) 2,2-dimethyl-4-hexanol
   d) 1,1,1-trimethyl-3-pentanol

4. What is the IUPAC name for this structure?
   a) 3-bromo-4-methylheptanone
   b) 5-bromo-4-methylheptanone
   c) 5-bromo-4-methyl-3-heptanone
   d) 3-bromo-4-methyl-5-heptanone

9. What is the IUPAC name of this compound?
   a) m-hydroxy-m-xylene
   b) 3,5-dimethylphenol
   c) 2,4-dimethyl-6-hydroxybenzene
   d) 3-hydroxy-5-methyltoluene

Answer: 1, b; 4, c; 9, b.
1) identify the lowest-energy Lewis structure for nitrogen oxide. (Formal charges not shown.)

(A) \( \text{N} \equiv \text{N} - \text{O} \) : 

(B) \( \text{N} \equiv \text{N} = \text{O} \) : 

(C) \( \text{N} \equiv \text{N} - \text{O} \) : 

(D) \( \text{N} = \text{N} = \text{O} \) :

8) The heat of combustion (per CH2) of several cycloalkanes is listed below. Based on the data given, which of these cycloalkanes would be considered most stable.

<table>
<thead>
<tr>
<th>Heat of combustion (kJ/CH2)</th>
<th>Cycloalkane</th>
</tr>
</thead>
<tbody>
<tr>
<td>-686.5</td>
<td>cyclobutane</td>
</tr>
<tr>
<td>-664.0</td>
<td>cyclopentane</td>
</tr>
<tr>
<td>-663.6</td>
<td>cyclooctane</td>
</tr>
<tr>
<td>-659.0</td>
<td>cyclopentadecane</td>
</tr>
</tbody>
</table>

a) cyclobutane  b) cyclopentane  c) cyclooctane  d) cyclopentadecane

11) Which pair consists of the resonance structure?

(A) \( \begin{array}{c} \text{CH}_3 \text{CH}_3 \\ \text{C} \equiv \text{C} \end{array} \)

(B) \( \begin{array}{c} \text{CH}_3 \text{CH}_3 \\ \text{C} \equiv \text{C} \end{array} \)

(C) \( \begin{array}{c} \text{CH}_2 \text{CH}_2 \\ \text{C} \equiv \text{C} \end{array} \)

(D) \( \begin{array}{c} \text{N} \equiv \text{O} \\ \text{CH}_3 \text{CH}_3 \end{array} \)

Answer: 1, c; 8, d; 11, a
**Acid and Bases Book P 30, 31**

1. Which structure corresponds to the predominant form of this molecule near pH 7?

\[
\text{CH}_3-\text{CH}-\text{C}-\text{OH} \quad \text{NH}_2
\]

(A) \[
\text{CH}_3-\text{CH}-\text{C}-\text{OH} \quad \text{NH}_3^+
\]

(B) \[
\text{CH}_3-\text{CH}-\text{C}-\text{O}^- \quad \text{NH}_2
\]

(C) \[
\text{CH}_3-\text{CH}-\text{C}-\text{O}^- \quad \text{NH}_3^+
\]

(D) \[
\text{CH}_3-\text{CH}-\text{C}-\text{OH} \quad \text{NH}_2
\]

4. Which is the order from the strongest acid to the weakest acid for these species?

A) II > IV > I > III

B) III > I > IV > II

C) III > IV > I > II

D) II > I > IV > III

<table>
<thead>
<tr>
<th>CH\text{OH}</th>
<th>CH\text{OH}_2^+</th>
<th>CH\text{NH}_2</th>
<th>CH\text{NH}_3^+</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
</tr>
</tbody>
</table>
8) Which of the indicated protons in this compound would have the smallest pKa values?

Stereoisomerism Book P38, 39.

1) Which molecule has the R configuration?

6) Which Newman projection represents the most stable configuration of \((\text{CH}_3)_2\text{CHCH(\text{CH}_3)}_2\)?
10) Which diastereoisomer is most stable?

Answer: 1, c; 6, c, 10, b.
**Nucleophilic Substitution and Elimination**

2) When 2-bromo-2-methybutane is treated with a base, a mixture of 2-methyl-2-butene and 2-methyl-1-butene is produced.

![Chemical Reaction Diagram](image)

When potassium hydroxide is the base, 2 methyl-1-butene accounts for 45% of the mixture, but when potassium tert-butoxide is the base, 2 methyl-1-butene accounts for 70% of the mixture. What would you predict for the percent of 2 methyl-1-butene in the mixture if the potassium prop-oxide were the base?

(a) Less than 45%
(b) 45%
(c) between 45% and 70%
(d) more than 70%
11) Why would the concentrated hydrobromic acid be an inappropriate catalyst for the dehydration of alcohols?

a) HBr is too weakly acidic to protonate the alcohol.

b) The conjugate base, Br–, is a good nucleophile and it would attack the carbocation to form an alkyl bromide.

c) HBr is strongly acidic, so the water molecule would not be a good leaving group after protonation of the alcohol.

d) HBr would be more likely to promote rearrangement of the carbocation intermediate.

17) What would be the first step in the dehydration of cyclohexanol in sulfuric acid?

a) loss of OH–

b) loss of H+ by the alcohol

c) formation of a sulfite ester

d) protonation of the alcohol

Answer: 2, c, 11, b, 17, d.
Electrophilic Additions

7) which set of the reagents will carry out the conversion shown?

![Chemical structure]

(A) $\text{H}_2\text{O}$, peroxides  
(B) $\text{H}_2\text{O}$, $\text{H}^+$  
(C) $\text{B}_2\text{H}_6$ followed by $\text{H}_2\text{O}_2$, $\text{NaOH}$  
(D) $\text{Hg(OAc)}_2$, $\text{H}_2\text{O}$ followed by $\text{NaBH}_4$

Answer: 7, c

Nucleophilic Addition at Carbonyl Groups

8) which compound would be most rapidly hydrolyzed by aqueous HC to give methanol as one of the products?

![Chemical structures]

(A) $\text{CH}_3\text{OCH}_2\text{CH}_2\text{CH}_3$  
(B) $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OCH}_3$  
(C) $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OH}$  
(D) $\text{CH}_3\text{CH}_2\text{CH}$

Answer: 7, c
12) which is the best reagent for this conversion?

(A) D$_2$O, containing catalytic amounts of HCl
(B) NaBD$_4$ in CH$_3$CH$_2$OH (and an aqueous workup)
(C) NaOD in CH$_3$CH$_2$OD (and an aqueous workup)
(D) D$_2$O in CH$_3$CO$_2$H

17) which reagent will accomplish the conversion shown?

(A) CH$_3$I
(B) CH$_3$MgBr
(C) CH$_3$Li
(D) (CH$_3$)$_2$CuLi

Answer: 8, d, 12, b, 17, d.
Nucleophilic Substitution at Carbonyl Groups

1) This reaction that is typical of carboxylic acids, ester, acid halides, anhydrides, and amides is called.

\[ R - C - H + H_2O \rightarrow R - C - OH + HCl \]

(a) nucleophilic non-acyl substitution
(b) nucleophilic addition
(c) nucleophilic acyl substitution
(d) electrophilic substitution

3) Which would be hydrolyzed most slowly with aqueous NaOH?

(A) \[ O \]
   \[ CH_3 - C - NHCH_3 \]

(B) \[ O \]
   \[ CH_3 - C - OCH_3 \]

(C) \[ O \]
   \[ CH_3 - C - O - C - CH_3 \]

(D) \[ O \]
   \[ CH_3 - C - Cl \]
13) Which reaction sequence is preferred for this conversation?

![Reaction Diagram]

(A) \[
\text{CH}_3\text{MgBr} \rightarrow \text{H}_2\text{O} \rightarrow \text{H}^+ \]

(B) \[
\text{SOCl}_2 \rightarrow (\text{CH}_3)_2\text{CuLi} \]

(C) \[
\text{SOCl}_2 \rightarrow \text{CH}_3\text{Li} \rightarrow \text{H}_2\text{O} \rightarrow \text{H}^+ \]

(D) \[
\text{SOCl}_2 \rightarrow \text{CH}_3\text{MgBr} \rightarrow \text{H}_2\text{O} \rightarrow \text{H}^+ \]

Answer: 1, c, 3, a, 13, b.

---

**Enols and Enolate Ion Reactions pg. 97**

16) The first two steps in the base-catalyzed condensation of acetaldehyde would be described as:

A) attack of \(^{-}\text{OH}\) on the carbonyl carbon atom, then loss of water.

B) attack of \(^{-}\text{OH}\) on the carbonyl carbon atom, then the resultant anion attacks the carbonyl atom on a second molecule of acetaldehyde.

C) \(^{-}\text{OH}\) abstracts an \(\alpha\)-hydrogen, then the resultant anion attacks the carbonyl carbon atom on a second molecule acetaldehyde.

D) \(^{-}\text{OH}\) abstracts the hydrogen atom from the carbonyl carbon, the then resultant anion attacks the carbonyl carbon atom on a second molecule of acetaldehyde.
20) Which represents a keto-enol tautomerization?

(A) \[
\begin{align*}
\text{CH}_2-C-\text{CH}_3 & \iff \text{CH}_2=\text{C}-\text{CH}_3 \\
\end{align*}
\]

(B) \[
\begin{align*}
\text{CH}_3-C-\text{CH}_3 & \iff \text{CH}_3-\text{C}^+\text{CH}_3 \\
\end{align*}
\]

(C) \[
\begin{align*}
\text{CH}_3-C-\text{CH}_3 & \iff \text{CH}_3-\text{CH}-\text{CH}_3 \\
\end{align*}
\]

(D) \[
\begin{align*}
\text{CH}_3-C-\text{CH}_3 & \iff \text{CH}_2=\text{C}-\text{CH}_3 \\
\end{align*}
\]

24) What is the product formed from this reaction?

\[
\begin{align*}
\text{C-CH}_3 & \xrightarrow{1. \text{Cl}_2, \text{NaOH}} \xrightarrow{2. \text{H}_2\text{O}, \text{H}^+} \\
\end{align*}
\]

(A) \[
\begin{align*}
\text{C}-\text{Cl} \\
\end{align*}
\]

(B) \[
\begin{align*}
\text{C}-\text{CH}_2\text{OH} \\
\end{align*}
\]

(C) \[
\begin{align*}
\text{C}-\text{CH}_3 \\
\end{align*}
\]

(D) \[
\begin{align*}
\text{C}-\text{OH} \\
\end{align*}
\]

Answer: 16, c; 20, d; 24, d.
1. Which substituents would deactivate benzene toward electrophilic aromatic substitution reaction?

\[ \text{G} = \begin{array}{c} \text{C} \\text{C} \text{H}_3 \\ \text{O} \text{H} \end{array} \quad \begin{array}{c} \text{N}^+ \text{CH}_3 \\ \text{CH}_3 \ \text{OH} \end{array} \]

A) I, II, III  
B) I and II only  
(C) II only  
(D) I and III only

4. Which set of reagents would most likely bring about this transformation?

\[ \begin{array}{c} \text{CH}_3 \quad \text{Br} \\ \text{CH}_3 \end{array} \]

(A) \( \text{Br}_2 \) with \( \text{FeBr}_3 \)  
(B) \( \text{Br}_2 \) in \( \text{CCl}_4 \)  
(C) \( \text{Br}_2 \) with UV light  
(D) \( \text{NaBr} \) with \( \text{H}_2\text{SO}_4 \)

Answer: 1, b; 4, a.
Free-Radicals Substitution and Additions

1. Which radical is the least stable?

5. What is the expected product of this reaction?

Answer: 1, b; 5, c.
1. Which reagents are best for carrying out this reaction?

   ![Chemical structure with options](image)

   (A) NaBH₄, then H₃O⁺
   (B) Zn(Hg), conc. HCl
   (C) LiAlH₄, ether; then aqueous workup
   (D) NH₂NH₂, KOH

3. Which reagents would best accomplish this transformation?

   ![Chemical structure with options](image)

   (A) K₂Cr₂O₇ + H₂SO₄
   (B) KMnO₄, KOH, then neutralization
   (C) I₂, KOH, then neutralization
   (D) H₂O₂, KOH, then neutralization
6. reduction of a triple bond to a E (trans) double bond can be accomplished with which set of reagents?

(A) Na, NH₃
(B) H₂, deactivated Pd
(C) NaBH₄, methanol
(D) NaH, then H₃O⁺

Answer: 1, a; 3, c; 6, a.
Spectroscopy

1. Which ketone will show a carbonyl absorption at the lower frequency (cm\(^{-1}\)) in the infrared?

(A) ![Structure A]

(B) ![Structure B]

(C) ![Structure C]

(D) ![Structure D]
3. Which is the reasonable structure for a compared with this IR spectrum?

(A) \[
\text{CH}_3\text{CH}_2\text{CH}_2\text{CCH}_3
\]

(B) \[
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}
\]

(C) \[
\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCH}_3
\]

(D) \[
\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_3
\]
5. Which structure is most consistent with this IR spectrum?

Answer: 1, b; 3, a; 5, d.
**Synthesis and Qualitative Analysis**

12. Which would be a suitable solvent for the preparation of ethyl-magnesium bromide from ethyl bromide and magnesium?

   a) CH₃CO₂CH₂CH₃  
   b) CH₃CH₂OH  
   c) CH₃OCH₂CH₂OCH₃  
   d) CH₃CO₂H

14. Which reaction sequence might be used to synthesize this compound?

Answer: 12, c; 14, a.