1. All of the following statements concerning buffers are true EXCEPT:

   A. buffers are resistant to pH changes upon addition of small quantities of strong acids or bases.
   B. buffers are only effective when the desired pH is greater than ±1 unit from the pK_a.
   C. the pH of a buffer is close to the pK_a of the weak acid from which it is made.
   D. buffers contain appreciable quantities of a weak acid and its conjugate base.
   E. buffers are resistant to changes in pH when diluted with water.

2. What is the effect of adding 10 mL of 0.1 M NaOH(aq) to 100 mL of 0.2 M NH_4^+(aq)?
   NO 1. The pH will decrease.
   NO - pH INCREASES AS CONJ. BASE FORMS
   YES 2. The concentration of NH_3 will increase. \( \text{NH}_3 = \text{CONJ. BASE} \)
   YES 3. The concentration of NH_4^+ will decrease.

   A. 1 only
   B. 2 only
   C. 3 only
   D. 2 and 3
   E. 1, 2 and 3

3. Each of the following mixtures can produce an effective buffer solution EXCEPT

   A. HClO_4 and NaClO_4  STRONG ACID
   B. HF and NaF
   C. NaHCO_3 and Na_2CO_3
   D. Na_2HPO_4 and Na_3PO_4
   E. NH_4Cl and NH_3

4. What is the pH of a solution containing 0.015 M sodium benzoate (C_6H_5COO^-) and 0.054 M benzoic acid (C_6H_5COOH)? \( K_a \) (benzoic acid) = 6.3x10^{-5}

   \[ \text{pH} = -\log(6.3 \times 10^{-5}) + \log\left(\frac{0.015}{0.054}\right) \]

   A. 3.64
   B. 4.20
   C. 4.76
   D. 7.0
   E. 3.2
5. A volume of 25.0 mL of 0.100 M formic acid, HCO₂H(aq), is titrated with 0.100 M NaOH(aq).

What is the pH after the addition of 12.5 mL of NaOH? (Kₐ for HCO₂H = 1.8 x 10⁻⁴)

\[
\text{moles Formic Acid (FA)} = (0.250 \times 0.100 \text{ M}) = 2.5 \times 10^{-3} \text{ moles}
\]

A. 2.52
B. 3.74
C. 4.74
D. 7.00
E. 10.26

6. Potassium hydrogen phthalate, KHC₈H₄O₄ (KHP; molar mass = 204.2 g/mol), is used to standardize sodium hydroxide. If 26.37 mL of NaOH(aq) is required to titrate 0.7719 g KHP to the equivalence point, what is the concentration of the NaOH(aq)?

\[
\text{KHC}_{8}\text{H}_{4}\text{O}_{4}^{-}(aq) + \text{OH}^{-}(aq) = \text{C}_{8}\text{H}_{4}\text{O}_{4}^{2-}(aq) + \text{H}_{2}\text{O}(l)
\]

\[
\text{AT EQUIL. PT IN AN ACID BASE TITRATN:} \quad \text{moles ACID} = \text{moles BASE}
\]

A. 0.02036 M
B. 0.02937 M
C. 0.09968 M
D. 0.1433 M
E. 5.977 M

7. Given the following graph, determine:
   a. the pH at the equivalence point
   b. the volume of titrant required to reach the equivalence point
   c. the type of titration

\[\text{pH} \quad \text{Volume of acid added (mL)}
\]

A. 4.3 54.0 mL  Weak Base with a Strong Acid
B. 4.3 54.0 mL  Weak Acid with a Strong Base
C. 7.6 27.0 mL  Weak Base with a Strong Acid
D. 7.6 27.0 mL  Weak Acid with a Strong Base
E. 4.3 54.0 mL  Strong Base with a Strong Acid
8. Given the following titration curve, respectively, what is the pH of the equivalence point and what is the pKa for the conjugate acid?

A. 5.0 and 9.3  
B. 2.0 and 5.0  
C. 9.3 and 5.0  
D. 11.0 and 9.5  
E. cannot be answered without more information

9. Which of the compounds listed below is the most likely to display the given titration curve?

A. H₂SO₃  
B. H₃PO₄  
C. NH₃  
D. CH₃CO₂H  
E. HClO₂
10. What volume of 0.50 M NaOH should be added to 2.0 L of 0.25 M HCO₃⁻ to make a buffer with a pH of 10.02? (pKₐ of HCO₃⁻ = 10.32)

\[ \text{pH} = pK_a + \log \left( \frac{\text{moles H}_2\text{O}}{\text{moles HCO}_3^-} \right) \]

\[ \text{pH} = 10.02 = 10.32 + \log \left( \frac{\text{moles H}_2\text{O}}{\text{moles HCO}_3^-} \right) \]

\[ 0.30 = \log \left( \frac{\text{moles H}_2\text{O}}{\text{moles HCO}_3^-} \right) \]

\[ 10^{-0.30} = \frac{\text{moles H}_2\text{O}}{\text{moles HCO}_3^-} \]

\[ \frac{\text{moles H}_2\text{O}}{\text{moles HCO}_3^-} = 0.50 \]

\[ \text{moles H}_2\text{O} = (2.04)(0.50 \text{ mole}) = 1.02 \text{ mole} \]

\[ \text{moles HCO}_3^- = \frac{1.02 \text{ mole}}{0.50} = 2.04 \text{ mole} \]

\[ \text{moles A} = \frac{2.04 \text{ mole}}{2.5 \times 10^2 \text{ mL}} = 0.00816 \text{ mole/L} \]

\[ \text{moles B} = 0.50 \text{ mole} \]

\[ \text{moles C} = 3.3 \times 10^2 \text{ mL} \]

\[ \text{moles D} = 1.64 \text{ mole} \]

\[ \text{moles E} = 3.32 \text{ mL} \]

11. In alkynes the two carbons making the triple bond have what hybridization?

A. sp
B. sp²
C. sp³
D. sp⁴
E. They are unhybridized

12. What is the geometry about the triple bond in alkynes?

A. linear
B. trigonal
C. tetrahedral
D. square planar
E. cyclic

13. Identify the formula for an alkyne.

A. CₙH₂n+2
B. CₙH₂n-2
C. CₙH₂n
D. CₙH₂n-4
E. CₙH₂n+4

14. Which of the following molecules is chiral?

A. Only i
B. Only iii.
C. All
D. i. and ii.
E. ii and iii
15. Which of the following compounds exhibits optical isomerism?

A. CH₃-CH₂-CH₃  
B. CH₃-CH₂-CHBr-CH₃  
C. CH₃-CHCl-CH₃  
D. CH₃-CH₂-CH₂Br  
E. CH₃-CH₂-CBr₂-CH₃

16. Shown below are 5 structures. Four are molecule are identical, one is different. Which molecule is different from the others?

A. i  
B. ii  
C. iii  
D. iv  
E. v
17. Consider the molecules drawn below.

Which is an alkene?  
Which is an ester?  
Which is an ether?

\[ \text{i. } \quad \text{ii. } \quad \text{iii. } \]
\[ \text{iv. } \quad \text{v. } \quad \text{vi. } \]

\begin{array}{ccc}
\text{alkene} & \text{ester} & \text{ether} \\
A. i & v & vi \\
B. iii & v & iv \\
C. ii & vi & v \\
D. iii & iv & v \\
E. ii & v & iv \\
\end{array}

18. The following figure is used for three questions.

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

Name the functional groups at the specified carbons.

\begin{align*}
\text{C-2} & : \\
\text{A. Ketone} & : \text{amide} \\
\text{B. Aldehyde} & : \text{aldehyde and amine} \\
\text{C. Alcohol} & : \text{amine and ketone} \\
\text{D. Ester} & : \text{carboxylic acid} \\
\text{E. Alkene} & : \text{amino acid} \\
\end{align*}
19. Name the compound.

\[
\begin{align*}
\text{CH}_3 \\
\text{H}_2\text{C} & \equiv \text{CH} \text{CH}_2\text{CH}_3 \\
\text{1} & \text{2} & \text{3} & \text{4} & \text{5}
\end{align*}
\]

A. 2-methyl-4-pentene  
B. 1,1-dimethyl-3-butene  
C. 4-methyl-1-pentene  
D. hexene  
E. 2-methylpentane

20. Name the compound.

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \\
\text{CH}_3\text{CH}_2\text{CC} \equiv \text{CH} \\
\text{CH}_2\text{CH}_2\text{CH}_3 \\
\end{align*}
\]

A. 3-butyl-3-propyl-1-heptyne  
B. 3-butyl-3-propyl-4-heptyne  
C. 3-ethyl-3-propyl-1-heptyne  
D. 5-ethyl-5-propyl-6-heptyne  
E. 3-ethyl-3-butyl-1-hexyne

21. Name the following compound.

\[
\begin{align*}
\text{Cl} & \text{Cl} \\
\text{Cl} & \text{Cl} \\
\text{Cl} & \text{Cl} \\
\text{Cl} & \text{Cl} \\
\text{Cl} & \text{Cl}
\end{align*}
\]

A. 2,4-dichlorobenzene  
B. 3,5-dichlorophenol  
C. 2,4-dichlorotoluene  
D. 2,4-dichlorophenol  
E. 1-hydroxy-3,5-dichlorobenzene
22. Name the following compound.

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

A. 2-butanal  
B. 3-butanol  
C. 2-methyl-2-ethylbutanone  
D. 2-butanone  
E. 2-methylpropanone

23. Name the following compound.

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

A. propyl butanoate  
B. butanoic acid  
C. 1-butanal  
D. 1-butanoate  
E. propyl methanoate

24. Which of the following compounds is methyl propyl ether?

A. \[ \text{CH}_3-\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \]  
B. \[ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{C}-\text{O}-\text{CH}_2-\text{CH}_3 \]  
C. \[ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{C}-\text{OH} \]  
D. \[ \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_3 \]  
E. \[ \text{CH}_3-\text{CH}_2-\text{C}-\text{CH}_3 \]
25. Name the compound:

A. 4-ethyl-3-methyl-3-phenyl-pentanal
B. 3-isobutyl-3-methyl-3-benzyl-1-butanal
C. 3,4-dimethyl-3-phenyl-hexanal
D. 3-ethyl-4-methyl-3-benzyl-1-hexanone
E. 3,4-dimethyl-4-phenyl-hexanal