UNIT IV: ACID & BASE PART I REVIEW

I. **Multiple Choice:**

1) In which of the following is HSO$_3^-$ acting as a Brønsted-Lowry acid?
   
   A. HSO$_3^-$ + H$_2$O $\rightarrow$ H$_2$SO$_3$ + OH$^-$
   B. NH$_3$ + HSO$_3^-$ $\rightarrow$ NH$_4^+$ + SO$_3^{2-}$
   C. HSO$_3^-$ + HPO$_4^{2-}$ $\rightarrow$ H$_2$SO$_3$ + PO$_4^{3-}$
   D. H$_2$C$_2$O$_4$ + HSO$_3^-$ $\rightarrow$ HC$_2$O$_4^-$ + H$_2$SO$_3$

2) What is the conjugate base of H$_2$PO$_4^-$?
   
   A. OH$^-$
   B. PO$_4^{3-}$
   C. HPO$_4^{2-}$
   D. H$_3$PO$_4$

3) Which of the following describes the relationship between acid strength and $K_a$ value for weak acids?

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<thead>
<tr>
<th>Acid Strength</th>
<th>$K_a$</th>
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<tbody>
<tr>
<td>A. decreases</td>
<td>increases</td>
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<td>B. decreases</td>
<td>remains constant</td>
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<td>C. increases</td>
<td>increases</td>
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<td>D. increases</td>
<td>decreases</td>
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4) Which of the following is the strongest acid that can exist in an aqueous solution?

   A. O$_2^-$
   B. NH$_2^-$
   C. H$_3$O$^+$
   D. HClO$_4$

5) What is the pH of a 0.050M KOH solution?

   A. 0.30
   B. 1.30
   C. 12.70
   D. 13.70

6) What is the value of $K_b$ for H$_2$PO$_4^-$?

   A. 1.3 x 10$^{-12}$
   B. 6.2 x 10$^{-8}$
   C. 1.6 x 10$^{-7}$
   D. 7.5 x 10$^{-3}$

7) Which of the following is the net ionic equation for the neutralization of HNO$_3$(aq) with Sr(OH)$_2$(aq)?

   A. H$^+(aq)$ + OH$^-(aq)$ $\rightarrow$ H$_2$O(l)
   B. Sr$^{2+}(aq)$ + 2NO$_3^-(aq)$ $\rightarrow$ Sr(NO$_3$)$_2(s)$
   C. 2HNO$_3$(aq) + Sr(OH)$_2$(aq) $\rightarrow$ Sr(NO$_3$)$_2$(aq) + 2H$_2$O(l)
   D. 2H$^+(aq)$ + 2NO$_3^-(aq)$ + Sr$^{2+}(aq)$ + 2OH$^-(aq)$ $\rightarrow$ Sr$^{2+}(aq)$ + 2NO$_3^-(aq)$ + 2H$_2$O(l)
8) Water will act as an acid with which of the following?

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<td>H₂CO₃</td>
</tr>
<tr>
<td>II</td>
<td>HCO₃⁻</td>
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<tr>
<td>III</td>
<td>CO₃²⁻</td>
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A. I only.  B. III only.  C. I and II only.  D. II and III only.

9) Which of the following 1.0M solutions will have the greatest electrical conductivity?

A. HI  B. H₂S  C. HCN  D. H₃PO₄

10) An acid is added to water and a new equilibrium is established. The new equilibrium can be described by:

A. pH < pOH and K_w = 1 × 10⁻¹⁴  
B. pH < pOH and K_w < 1 × 10⁻¹⁴  
C. pH > pOH and K_w = 1 × 10⁻¹⁴  
D. pH > pOH and K_w > 1 × 10⁻¹⁴

11) Consider the following equilibrium:

\[ \text{2H}_2\text{O}(l) + \text{energy} \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{OH}^-(aq) \]

The \([\text{H}_3\text{O}^+]\) will decrease and the K_w will remain constant when

A. a strong acid is added.  C. the temperature is increased.  
B. a strong base is added.  D. the temperature is decreased.

12) Which of the following graphs describes the relationship between \([\text{H}_3\text{O}^+]\) and pH?

A. 

\[ [\text{H}_3\text{O}^+] \]

pH  

B. 

\[ [\text{H}_3\text{O}^+] \]

pH  

C. 

\[ [\text{H}_3\text{O}^+] \]

pH  

D. 

\[ [\text{H}_3\text{O}^+] \]

pH
13) When the $[H_3O^+]$ in a solution is increased to twice the original concentration, the change in pH could be from

A. 1.7 to 1.4  
B. 2.0 to 4.0  
C. 5.0 to 2.5  
D. 8.5 to 6.5

14) The relationship $\frac{[H_2P_2O_7^{2-}][H_3O^+]}{[H_3P_2O_7^-]}$ is the

A. $K_a$ for $H_3P_2O_7^-$  
B. $K_b$ for $H_3P_2O_7^-$  
C. $K_a$ for $H_2P_2O_7^{2-}$  
D. $K_b$ for $H_2P_2O_7^{2-}$

15) Which of the following describes the relationship between acid strength and $K_a$ value for weak acids?

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16) The value of $K_b$ for $HPO_4^{2-}$ is:

A. $2.2 \times 10^{-13}$  
B. $6.2 \times 10^{-8}$  
C. $1.6 \times 10^{-7}$  
D. $4.5 \times 10^{-2}$

17) What volume of 0.100M NaOH is required to completely neutralize 15.00mL of 0.100M $H_3PO_4$?

A. 5.00mL  
B. 15.0 mL  
C. 30.0mL  
D. 45.0 mL

18) What is the pH of the solution formed when 0.060 moles NaOH is added to 1.00 L of 0.050M $HCl$?

A. 2.00  
B. 7.00  
C. 12.00  
D. 12.78

19) The conjugate acid of $C_6H_5NH_2$ is:

A. $C_6H_5NH^-$  
B. $C_6H_5NH_3$  
C. $C_6H_5NH_2^+$  
D. $C_6H_5NH_3^+$

20) Which of the following is a property of 1.0M $HCl$ but not a property of 1.0M $CH_3COOH$?

A. turns litmus red  
B. ionizes completely  
C. has a pH less than 7.0  
D. produces $H_3O^+$ in solution
21) In a 1.0M HF solution, the concentration of HF, F\(^-\) and OH\(^-\), from highest to lowest is:

A. [HF] > [F\(^-\)] > [OH\(^-\)]
B. [F\(^-\)] > [HF] > [OH\(^-\)]
C. [OH\(^-\)] > [HF] > [F\(^-\)]
D. [OH\(^-\)] > [F\(^-\)] > [HF]

22) In which of the following reactions is water behaving as a Brønsted-Lowry acid?

A. \(2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2\)
B. \(\text{HCl} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-\)
C. \(\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^-\)
D. \(\text{NH}_4^+ + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{NH}_3\)

23) What is the [OH\(^-\)] of a solution with \([\text{H}_3\text{O}^+] = 9.3 \times 10^{-2} \text{ M}\)

A. 9.3 x 10\(^{-16}\) M
B. 8.6 x 10\(^{-13}\) M
C. 1.1 x 10\(^{-13}\) M
D. 9.3 x 10\(^{-2}\) M

24) The pH of 0.10M HNO\(_3\) is:

A. 0.79
B. 1.00
C. 1.26
D. 13.00

25) What is the pOH of a solution made by adding 50.0mL of 0.50M NaOH to 250.0mL of water?

A. 0.30
B. 1.00
C. 1.08
D. 12.92

26) Which of the following 1.0M solutions will have the lowest pH?

A. HCl
B. HCN
C. H\(_3\)PO\(_4\)
D. H\(_2\)C\(_2\)O\(_4\)

27) In an aqueous solution of NaCl, the pH is:

A. less than 7 and the solution is acidic.
B. equal to 7 and the solution is neutral.
C. greater than 7 and the solution is basic.
D. greater than 7 and the solution is acidic.

28) How many moles of KOH are necessary to completely neutralize 42.0mL of 3.00M HCl?

A. 0.0630 moles
B. 0.126 moles
C. 0.252 moles
D. 3.00 moles

29) The solution with the lowest electrical conductivity is:

A. 0.10M H\(_2\)S
B. 0.10M HNO\(_2\)
C. 0.10M H\(_2\)SO\(_3\)
D. 0.10M NH\(_4\)Cl

30) The solution with the lowest pH is:

A. 1.0M HF
B. 1.0M HCN
C. 1.0M HCOOH
D. 1.0M CH\(_3\)COOH
31) As the [H₃O⁺] in a solution decreases, the [OH⁻]:
   A. increases and the pH increases.  C. decreases and the pH increases.
   B. increases and the pH decreases.  D. decreases and the pH decreases.

32) The value of pKₘᵢₙ at 25°C is;
   A. 1.0 x 10⁻¹⁴  C. 7.00
   B. 1.0 x 10⁻⁷  D. 14.00

33) Consider the following equilibrium:  \( 2\text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^- \)
   In pure water at a temperature of 50°C,
   A. pH < 7  C. \( K_w = 1.0 \times 10^{-14} \)
   B. pH + pOH = 14  D. [OH⁻] < 1.0 x 10⁻⁷

34) What is the pOH of 2.5 M NaOH?
   A. -0.40  B. 0.0032  C. 0.40  D. 13.60

35) A 0.010M acid solution has a pH of 2.00. The acid could be
   A. HNO₃  B. H₂SO₃  C. HCOOH  D. CH₃COOH

36) Consider the following:

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The term amphiprotic can be used to describe:
   A. I only.  B. II and III only.  C. I, II and III only.  D. II, III and IV only.

37) Calculate the [H₃O⁺] in a solution prepared by mixing 25.0mL of 1.0M HCl with 50.0mL of 0.50M KOH.
   A. 1.0 M  C. 0.25 M
   B. 0.50 M  D. 1.0 x 10⁻⁷ M
II. Short Answers:

1) Calculate the pH of 0.50M H₃BO₃.

2) Calculate the pH of 1.50M NH₃.

3) Calculate the pOH of 0.25M Sr(OH)₂.

4) A 2.00M diprotic acid has a pH of 0.50. Calculate its Kₐ value.

5) Calculate the pH of a solution prepared by adding 15.0 mL of 0.500M H₂SO₄ to 35.0 mL of 0.750M NaOH.

6) Determine the pH of a 0.75M solution of HPO₄²⁻.