Week 5 Acids & Bases, Strength, pH, Kw, Acids

**QUESTION 1**

A 0.1 M solution of an electrolyte has a pH of 4.0. What is the electrolyte?

A. a strong acid  
B. a strong base  
C. a weak acid  
D. a weak base  
E. a salt of a strong acid and a strong base

**QUESTION 2**

Explain why pure water is a poor conductor of electricity.

**QUESTION 3**

At 0°C, the ion-product constant of water, $K_w$, is $1.2 \times 10^{-15}$. What is the pH of pure water at 0°C?

A. 7.00  
B. 6.88  
C. 7.56  
D. 7.46  
E. 7.12

**QUESTION 4**

What is the pH of $1.3 \times 10^{-3}$ M aqueous sodium hydroxide solution at 25°C?

A. 11.1  
B. 8.3  
C. 7.9  
D. 2.9  
E. 10.1

**QUESTION 5**

What is the pH of a 0.053 M solution of KOH at 25°C?

A. 6.9  
B. 12.7  
C. 7.3  
D. 1.3  
E. 11.0

**QUESTION 6**

What is the $H^+$ concentration in a solution with a pH of 3.75?

A. $5.6 \times 10^3$  
B. $7.5 \times 10^{-3}$  
C. $5.6 \times 10^{-11}$  
D. $1.9 \times 10^{-4}$  
E. $2.5 \times 10^{-8}$

**QUESTION 7**

The pH of vinegar was measured to be 3.47 using a pH meter. What is the hydronium ion concentration, $[H_3O^+]$, in vinegar at 25°C?

A. $3.4 \times 10^{-4}$ M  
B. $1.7 \times 10^{-2}$ M  
C. 0.5 M  
D. 1.9 M  
E. None of the above answers is correct.
QUESTION 8
Milk of magnesia has a pH = 10.4. What is the hydroxide ion concentration at 25°C?

A. $1.0 \times 10^{-4}$ M
B. $2.5 \times 10^{-4}$ M
C. $4.0 \times 10^{-11}$ M
D. 3.6 M
E. $1.0 \times 10^{-11}$ M

QUESTION 9
What is the pOH of a 0.15 M solution of HBr at 25°C?

QUESTION 10
Determine how the pH of these solutions will change when 100 ml of H₂O is added separately to each of them. Then choose which statement is correct.

I. 100 mL of 0.02 M KCl
II. 100 mL of 0.02 M HCl

A. The pH of both (I) and (II) will remain the same.
B. The pH of (I) will remain the same but that of (II) will increase.
C. The pH of (II) will remain the same but that of (I) will increase.
D. The pH of (I) will remain the same but that of (II) will decrease.
E. The pH of (II) will remain the same but that of (I) will decrease.

QUESTION 11
A scientist prepares a solution by adding 300 mL of 0.03 M HCl to 500 mL of 0.02 M HClO₄. What is the pH of the resultant solution at 25°C?

A. 1.30
B. 1.00
C. 2.31
D. 0.05
E. 1.62

QUESTION 12
Which statements are true about strong acids?

I. Strong acids are weak electrolytes.
II. Strong acids have spectator ions as conjugate bases.
III. Strong acids have very large $K_a$ values.

A. I and II only
B. II and III only
C. I, II and III only
D. I and III only
E. I only

QUESTION 13
Which of the following is NOT a strong acid?

A. HCl
B. HClO₃
C. $H_2SO_4$
D. $H_3PO_4$
E. HClO₄
QUESTION 14

Which of the following substances are spectator ions in aqueous solution?

I. Br⁻
II. NO₃⁻
III. S²⁻
IV. OH⁻
V. ClO₃⁻
VI. F⁻
VII. H⁺
VIII. Cl⁻
IX. CH₃COO⁻

QUESTION 15

What is the concentration of HNO₃ in a solution that has a pH of 0.98?

QUESTION 16

Which of the following is true regarding a 0.10 M solution of a weak acid HX, which has a $K_a = 1 \times 10^{-6}$?

A. $[X^-] = 0.10$ M
B. $[H^+] = 0.10$ M
C. pH = 1
D. $[HX] > [H^+]$
E. pH = 10

QUESTION 17

Write the chemical equation and the equilibrium constant expression $K_a$ for the following acids in aqueous solution (you may write $H^+$ instead of the hydronium ion):

a. H₂S
b. HCO₃⁻
c. CF₃COOH

QUESTION 18

What is the pH of an aqueous solution labeled 0.075 M HCN at 25°C? $K_a = 4.9 \times 10^{-10}$

A. 5.2
B. 8.8
C. 7.0
D. 10.4
E. 3.6

QUESTION 19

Calculate the hydronium ion concentration, $[H_3O^+]$, in 0.020 M hypochlorous acid at 25°C ($K_a = 3.0 \times 10^{-8}$).

A. $6.1 \times 10^{-10}$ M
B. $4.6 \times 10^{-6}$ M
C. $2.4 \times 10^{-5}$ M
D. $7.2 \times 10^{-1}$ M
E. $1.0 \times 10^{-7}$ M

QUESTION 20

What is the value of $K_a$ for the weak acid HA if a 0.35 M solution of HA has a pH of 5.95?

A. $3.2 \times 10^{-6}$
B. 1.7
C. $1.1 \times 10^{-6}$
D. $3.6 \times 10^{-12}$
E. $2.2 \times 10^{-16}$
QUESTION 21

What percent ionization would be expected for 0.400 M HN₃ at 25°C? (Kₐ = 1.9 × 10⁻⁵)

A. 70 %
B. 35 %
C. 3.5 %
D. 0.7 %
E. 5.0 %

QUESTION 22

What is the % ionization of hypochlorous acid (HClO) in a 0.015 M aqueous solution at 25°C? (Kₐ = 3.0 × 10⁻⁸)

A. 4.5 × 10⁻⁸ %
B. 14 %
C. 2.1 × 10⁻⁵ %
D. 0.14 %
E. 4.5 × 10⁻¹⁰ %

QUESTION 23

Consider the following two solutions: 0.01 M acetic acid and 0.001 M acetic acid (Kₐ = 1.8 × 10⁻⁵).

a. Which solution has a greater percent ionization, and why?
b. Which solution has a lower pH?

QUESTION 24

Which one of the following is true for any triprotic acid, H₃X?

A. Kₐ₁ > Kₐ₂
B. Kₐ₂ = Kₐ₁
C. Kₐ₁ < Kₐ₂
D. Kₐ₂ < Kₐ₃
E. Kₐ₁ = Kₐ₂ = Kₐ₃

QUESTION 25

A diprotic acid, H₂A, has values of Kₐ₁ = 1.0 × 10⁻⁵ and Kₐ₂ = 1.0 × 10⁻¹⁰. In a 0.10 M solution of H₂A, what is the concentration of the anion A²⁻?

A. 0.10 M
B. 0.20 M
C. 3.2 × 10⁻³ M
D. 1.0 × 10⁻³ M
E. 1.0 × 10⁻¹⁰ M

QUESTION 26

Given the acid-dissociation constants of phosphoric acid below (H₃PO₄), what is the concentration of phosphate ions in a 2.5 M aqueous solution of phosphoric acid if the pH of the solution is 0.87 at 25°C?

Kₐ₁ = 7.5 × 10⁻³
Kₐ₂ = 6.2 × 10⁻⁸
Kₐ₃ = 4.2 × 10⁻¹³

A. 1.9 × 10⁻¹⁹ M
B. 1.0 × 10⁻⁶ M
C. 0.13 M
D. 6.2 × 10⁻⁶ M
E. 4.2 × 10⁻¹³ M
QUESTION 27

Which of the following statements is true concerning the equilibria shown below?

\[ \text{H}_3\text{PO}_4(\text{aq}) = \text{H}_2\text{PO}_4^{-}(\text{aq}) + \text{H}^+(\text{aq}) \quad K_{a1} \]
\[ \text{H}_2\text{PO}_4^{-}(\text{aq}) = \text{HPO}_4^{2-}(\text{aq}) + \text{H}^+(\text{aq}) \quad K_{a2} \]
\[ \text{HPO}_4^{-}(\text{aq}) = \text{PO}_4^{3-}(\text{aq}) + \text{H}^+(\text{aq}) \quad K_{a3} \]

A. \( K_{a3} \) is larger than \( K_{a1} \).
B. \( \text{H}_2\text{PO}_4^{-}(\text{aq}) \) dissociates completely.
C. The pH of this aqueous solution is determined mainly by \( K_{a3} \).
D. The strongest conjugate base involved is the \( \text{PO}_4^{3-} \) species.
E. \( \text{HPO}_4^{-}(\text{aq}) \) is a stronger acid than \( \text{H}_2\text{PO}_4^{-}(\text{aq}) \).

QUESTION 28

Considering the equilibria below, what would change if 5 drops of concentrated HCl were added to an aqueous solution of \( \text{H}_3\text{PO}_4 \)?

I. [\( \text{H}_3\text{PO}_4 \)] would increase
II. [\( \text{PO}_4^{3-} \)] would decrease
III. [\( \text{OH}^- \)] would increase

\[ \text{H}_3\text{PO}_4(\text{aq}) = \text{H}_2\text{PO}_4^{-}(\text{aq}) + \text{H}^+(\text{aq}) \quad K_{a1} \]
\[ \text{H}_2\text{PO}_4^{-}(\text{aq}) = \text{HPO}_4^{2-}(\text{aq}) + \text{H}^+(\text{aq}) \quad K_{a2} \]
\[ \text{HPO}_4^{-}(\text{aq}) = \text{PO}_4^{3-}(\text{aq}) + \text{H}^+(\text{aq}) \quad K_{a3} \]

A. I, II and III
B. II and III only
C. I and III only
D. I and II only
E. III only

QUESTION 29

Hydrogen sulfite ion has a formula of \( \text{HSO}_3^- \).

a. Write an equation for the reaction in which hydrogen sulfite ion acts as an acid in aqueous solution.
b. Write an equation for the reaction in which hydrogen sulfite ion acts as a base in aqueous solution.
c. What type of substance can act as either an acid or a base?