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19 ACIDS, BASES, AND SALTS

Practice Problems

In your notebook, solve the following problems.

SECTION 19.1 ACID–BASE THEORIES

1. Identify the hydrogen ion donor(s) and hydrogen ion acceptor(s) for ionization of H_2SO_4 in water. Label the conjugate acid–base pairs.
2. Identify all of the ions that may be formed when H_3PO_4 ionizes in water.
3. Classify the following acids as monoprotic, diprotic, or triprotic.

   a. HCOOH **b.** HBr **c.** H_2SO_3 **d.** H_3ClO_4
4. What would you expect to happen when lithium metal is added to water? Show the chemical reaction.
5. In the following chemical reaction, identify the Lewis acid and base.

   $$BF_3 + F^- \rightleftharpoons BF_4^-$$
6. Describe some distinctive properties of acids.
7. Describe some distinctive properties of bases.

SECTION 19.2 HYDROGEN IONS AND ACIDITY

1. A solution has a hydrogen ion concentration of $1 \times 10^{-6}M$. What is its pH?
2. What is the pH of a solution if the $[H^+] = 7.2 \times 10^{-9}M$?
3. What is the pOH of a solution if the $[OH^-] = 3.5 \times 10^{-2}M$?
4. What is the pOH of a solution that has a pH of 3.4?
5. Classify each solution as acidic, basic, or neutral.

   a. $[H^+] = 2.5 \times 10^{-9}M$ **d.** $[H^+] = 1 \times 10^{-7}M$

   b. pOH = 12.0 **e.** pH = 0.8

   c. $[OH^-] = 9.8 \times 10^{-11}M$
6. Calculate the pH of each solution.

   a. $[H^+] = 1 \times 10^{-5}M$ **c.** $[OH^-] = 2.2 \times 10^{-7}M$

   b. $[H^+] = 4.4 \times 10^{-11}M$ **d.** pOH = 1.4
7. Classify the solutions in problem 6 as acidic or basic.
8. Why is there a minus sign in the definition of pH?
9. A solution has a pOH of 12.4. What is the pH of this solution?
10. What is the pH of a solution with $[H^-] = 1 \times 10^{-3}M$?

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SECTION 19.3 STRENGTHS OF ACIDS AND BASES

1. Rank 1*M* of these compounds in order of increasing hydrogen ion concentration: weak acid, strong acid, strong base, weak base.
2. Write the expression for the acid dissociation constant of the strong acid hydrofluoric acid, HF.
3. Write the expression for the base dissociation constant for hydrazine, N_2H_4, a weak base. Hydrazine reacts with water to form the $N_2H_5^+$ ion.
4. Use Table 19.8 in your textbook to rank these acids from weakest to strongest: HOOCCOOH, HCO_3^-, $H_2PO_4^-$, HCOOH.
5. Write the equilibrium equation and the acid dissociation constant for the following weak acids.

   a. H_2S **b.** NH_4^+ **c.** C_6H_5COOH
6. Match each solution with its correct description.

   a. dilute, weak acid (1) $18M\ H_2SO_4(aq)$
   b. dilute, strong base (2) $0.5M\ NaOH(aq)$
   c. concentrated, strong acid (3) $15M\ NH_3(aq)$
   d. dilute, strong acid (4) $0.1M\ HC_2H_3O_2(aq)$
   e. concentrated, weak base (5) $0.1M\ HCl(aq)$
7. Write the base dissociation constant expression for the weak base analine, $C_6H_5NH_2$.
   $$C_6H_5NH_2(aq) + H_2O(l) \rightleftharpoons C_6H_5NH_3^+(aq) + OH^-(aq)$$
8. A 0.10*M* solution of formic acid has an equilibrium $[H^+] = 4.2 \times 10^{-3}M$.
   $$HCOOH(aq) \rightarrow H^+(aq) + HCOO^-(aq)$$
   What is the K_a of formic acid?
9. The K_a of benzoic acid, C_6H_5COOH, is 6.3×10^{-5}. What is the equilibrium $[H^+]$ in a 0.20*M* solution of benzoic acid?
10. A 0.10*M* solution of hydrocyanic acid, HCN, has an equilibrium hydrogen ion concentration of $6.3 \times 10^{-6}M$. What is the K_a of hydrocyanic acid?

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SECTION 19.4 NEUTRALIZATION REACTIONS

1. What is the molarity of a sodium hydroxide solution if 38 mL of the solution is titrated to the end point with 14 mL of 0.75*M* sulfuric acid?
2. If 24.6 mL of a $Ca(OH)_2$ solution is needed to neutralize 14.2 mL of 0.0140*M* $HC_2H_3O_2$, what is the concentration of the calcium hydroxide solution?
3. A 12.4 mL solution of H_2SO_4 is completely neutralized by 19.8 mL of 0.0100*M* $Ca(OH)_2$. What is the concentration of the H_2SO_4 solution?
4. What volume of 0.12*M* $Ba(OH)_3$ is needed to neutralize 12.2 mL of 0.25*M* HCl?
5. A 55.0-mg sample of $Al(OH)_3$ is reacted with 0.200*M* HCl. How many milliters of the acid are needed to neutralize the $Al(OH)_3$?

SECTION 19.5 SALTS IN SOLUTION

1. A buffer solution is prepared by mixing together equal quantities of formic acid, $HCHO_2$, and sodium formate, $NaCHO_2$. Write equations that show what happens when first acid, and then base, is added to this buffer solution.
2. Complete the following rules.
   a. strong acid + strong base →
   b. strong acid + weak base →
   c. weak acid + strong base →