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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.** $[H^+] = 2.5 \times 10^{-9} M$
   **b.** pOH = 12.0
   **c.** $[OH^-] = 9.8 \times 10^{-11} M$
   **d.** $[H^+] = 1 \times 10^{-7} M$
   **e.** pH = 0.8
6. Calculate the pH of each solution.
   **a.** $[H^+] = 1 \times 10^{-5} M$
   **b.** $[H^+] = 4.4 \times 10^{-11} M$
   **c.** $[OH^-] = 2.2 \times 10^{-7} M$
   **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) 18*M* $H_2SO_4(aq)$ |
| **b.** dilute, strong base | (2) 0.5*M* NaOH(*aq*) |
| **c.** concentrated, strong acid | (3) 15*M* $NH_3(aq)$ |
| **d.** dilute, strong acid | (4) 0.1*M* $HC_2H_3O_2(aq)$ |
| **e.** concentrated, weak base | (5) 0.1*M* 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 $6.3 \times 10^{-5}$. 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 →