

Acids and Bases

Section 19.1 Acids and Bases: An Introduction

In your textbook, read about the properties of acids and bases.

For each description below, write *acid* if it tells about a property of an acid or *base* if it tells about a property of a base. If the property does not apply to either an acid or a base, write *neither*. If it applies to both an acid and a base, write *both*.

- both 1. Can turn litmus paper a different color
- acid 2. Reacts with certain metals
- acid 3. Contains more hydrogen ions than hydroxide ions
- base 4. Feels slippery
- acid 5. Reacts with carbonates
- neither 6. Feels rough
- neither 7. Contains equal numbers of hydrogen and hydroxide ions
- base 8. Tastes bitter
- acid 9. Tastes sour

In your textbook, read about the different models of acids and bases.

Use the terms below to complete the passage. You may use each term more than once.

Arrhenius	Brønsted-Lowry	conjugate acid
conjugate base	hydrogen	hydroxide

The (10) Arrhenius model of acids and bases states that an acid contains the element (11) hydrogen and forms ions of this element when it is dissolved in water. A base contains the (12) hydroxide group and dissociates to produce (13) hydroxide ions in aqueous solution.

According to the (14) Brønsted-Lowry model, an acid donates (15) hydrogen ions, and a base accepts (16) hydrogen ions.

According to this model, in an acid-base reaction, each acid has a (17) conjugate base and each base has a (18) conjugate acid.

Section 19.2 Strengths of Acids and Bases

In your textbook, read about strengths of acids.

Circle the letter of the choice that best completes the statement or answers the question.

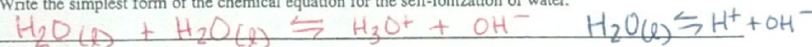
1. Acid A and acid B are of equal concentration and are tested with a conductivity apparatus. When the electrodes are placed in acid A, the bulb glows dimly. When they are placed in acid B, the bulb glows more brightly. Which of the following is true?
 - a. Acid A is stronger than acid B.
 - b. Acid B is stronger than acid A.
 - c. Acid A and acid B are of equal strength.
 - d. No comparison of strength can be made from the results.
2. A chemical equation for the ionization of an acid uses a single arrow to the right (\rightarrow) to separate the reactant and product sides of the equation. Which of the following is true?
 - a. The arrow does not indicate relative strength.
 - c. The ionizing acid is strong.
 - b. The ionizing acid is half ionized.
 - d. The ionizing acid is weak.
3. Sulfuric acid is a strong acid. What is true about its conjugate base?
 - a. Its conjugate base is amphoteric.
 - b. Its conjugate base is strong.
 - c. Its conjugate base is weak.
 - d. No conclusion can be made regarding the strength of the conjugate base.
4. In solution, a weak acid produces
 - a. a mixture of molecules and ions.
 - b. all ions.
 - c. all molecules.
 - d. anions, but no hydronium ions.
5. Why are K_a values all small numbers?
 - a. The concentration of water does not affect the ionization.
 - b. The equilibrium is not stable.
 - c. The solutions contain a high concentration of ions.
 - d. The solutions contain a high concentration of un-ionized acid molecules.
6. Which of the following dissociates entirely into metal ions and hydroxide ions in solution?
 - a. a strong acid
 - b. a strong base
 - c. a weak acid
 - d. a weak base
7. In general, compounds formed from active metals, and hydroxide ions are
 - a. strong acids.
 - b. strong bases.
 - c. weak acids.
 - d. weak bases.

Section 19.3 What is pH?

In your textbook, read about the ion product constant for water.

Answer the following questions.

1. Write the simplest form of the chemical equation for the self-ionization of water.



2. Write the equilibrium constant expression, K_{eq} , for this equation.

$K_w = [H_3O^+][OH^-]$ $K_w = [H^+][OH^-]$

3. Write the expression for the equilibrium constant for water, K_w .

$K_w = [H^+][OH^-]$

4. Why can the concentration of water be ignored in the equilibrium expression for water?

Water is a pure liquid. Its $[] = 1$

5. What is the numerical value of K_w at 298 K?

$K_w = 1 \times 10^{-14}$ @ 298K (25°C)

6. In solution, if the hydroxide ion concentration increases, what happens to the hydrogen ion concentration?

It decreases

7. If the concentration of hydroxide ions in solution is 1.0×10^{-6} , what is the hydrogen ion concentration?

$[H^+] = 1.0 \times 10^{-8}$

8. Is the solution in question 7 acidic, basic, or neutral? Explain.

Basic $[OH^-] > [H^+]$

In your textbook, read about pH and pOH.

In the space at the left, write *true* if the statement is true; if the statement is false, change the italicized word or number to make it true.

false 9. The pH of a solution is the negative logarithm of its *hydroxide* ^{hydrogen} ion concentration.

true 10. Values for pH range from 0 to 14.

false 11. Stomach contents can have a pH of 2, which means that they are *basic* ^{acidic}.

false 12. The hydrogen ion concentration in a solution with a pH of 3 is ¹⁰⁰ ~~two~~ times greater than the hydrogen ion concentration in a solution with a pH of 5.

Section 19.3 continued

true 13. The pH of a neutral solution at room temperature equals the pOH of the solution.

false 14. If the pH of a solution is 3, its pOH is ~~10~~ 11

true 15. The pH of a solution with a $[H^+]$ of 1×10^{-8} is 8.

false 16. The pH of a solution with a $[OH^-]$ of 1×10^{-6} is ~~8~~ 8

In your textbook, read about calculating the pH of acids and bases.

Solve each of the following problems. Show your work.

17. What is the pH of a $4.3 \times 10^{-2} M$ HCl solution? HCl is a strong acid.

$[H^+] = 4.3 \times 10^{-2} M$

$pH = -\log(4.3 \times 10^{-2}) = 1.3665$

18. Calculate the pH of a $5.2 \times 10^{-3} M$ H_2SO_4 solution? H_2SO_4 is a strong acid.

$[H^+] = 2(5.2 \times 10^{-3} M)$

$pH = -\log(10.4 \times 10^{-3}) = 1.98$

19. What is the pH of a $2.5 \times 10^{-5} M$ NaOH solution? NaOH is a strong base.

$[OH^-] = 2.5 \times 10^{-5} M$

$pOH = -\log(2.5 \times 10^{-5}) = 4.6$

$pH = 14 - 4.6 = 9.4$

20. Calculate the pH of a $3.6 \times 10^{-6} M$ $Ca(OH)_2$ solution. $Ca(OH)_2$ is a strong base.

$[OH^-] = 2(3.6 \times 10^{-6} M)$

$pOH = -\log(7.2 \times 10^{-6}) = 5.14$

$pH = 14 - 5.14 = 8.86$

In your textbook, read about measuring pH.

Complete the passage.

Indicator paper can be used to measure the (21) pH of a solution. Indicators are substances that are different (22) colors depending on the pH of the solution tested. Another way to measure the acidity of the solution is the (23) pH meter, which uses electrodes placed in solution to directly read the results.