

SECTION 3 **Solutions of Acids and Bases**

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are strong and weak acids?
- What are strong and weak bases?
- What happens when an acid reacts with a base?
- What is pH?

National Science Education Standards
PS 1b

What Is a Strong Acid or Base?

Acids and bases can be strong or weak. The strength of an acid or base is not the same as their concentration. *Concentration* means the amount of acid or base dissolved in water. The strength of an acid or base depends on the number of ions formed when they dissolve in water. ✓

STUDY TIP

Discuss Read this section silently. With a partner, take turns telling what the section is about. Stop to discuss ideas and words that confuse you.

STRONG VERSUS WEAK ACIDS

As an acid dissolves in water, the acid's molecules break apart to form hydronium ions, H_3O^+ . In water, all of the molecules of a *strong acid* break apart to form many ions. Sulfuric acid, nitric acid, and hydrochloric acid are all strong acids.

However, if you mix a weak acid in water, only a few of its molecules break apart. So there are only a few hydronium ions in a solution of a weak acid. Acetic acid, citric acid, and carbonic acid are all weak acids. ✓

READING CHECK

1. Explain What does the concentration of an acid or base solution tell you?

STRONG VERSUS WEAK BASES

A base is strong if it forms many hydroxide ions, OH^- , when dissolved in water. Sodium hydroxide, calcium hydroxide, and potassium hydroxide are strong bases. When only a few ions are formed, the base is a weak base. Two weak bases are magnesium hydroxide and aluminum hydroxide.

READING CHECK

2. Explain What is the difference between a strong acid and a weak acid?



Antacids are weak bases. They help relieve your stomachache by reacting with acid in your stomach.

SECTION 3 Solutions of Acids and Bases *continued***What Happens When Acids and Bases Mix?**

The base in an antacid reacts with the acid in your stomach. Why does your stomach feel better? Because the reaction between acids and bases makes the excess acid in your stomach neutral. This is called a **neutralization reaction**.

In a neutralization reaction, hydrogen ions (H^+) from the acid combine with hydroxide ions (OH^-) from the base. This reaction forms water, which is neutral. The other ions in the acid and base solution combine to form a compound called a *salt*. ✓

READING CHECK

3. Describe What two things are formed by a neutralization reaction?

READING CHECK

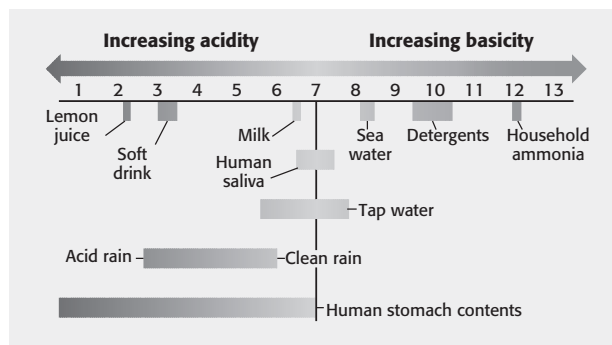
4. Describe What is pH?

5. Identify What kind of solution has a pH above 7? What kind has a pH below 7?

THE PH SCALE

An indicator such as litmus paper can show us if a solution contains an acid or a base. We use the pH scale to describe how acidic or basic a solution is.

The **pH** of a solution is a measure of how many hydronium ions it has. A solution that has a pH of 7 is neutral. A neutral solution is not acidic and it is not basic. Pure water has a pH of 7. Basic solutions have a pH greater than 7. Acidic solutions have a pH less than 7. ✓

pH Values of Common Materials**USING INDICATORS TO FIND PH**

There are several ways to find out how basic or acidic a solution is. For example, strips of pH paper have several different indicators on them. When you dip them into a solution, the pH paper changes color. You can compare that color to a color scale to find the pH of the solution. People use this kind of indicator to test the pH of water in swimming pools.

Another way to find the pH of a solution is to use an electronic device called a *pH meter*. These meters measure hydronium ion concentration in the solution.

SECTION 3 Solutions of Acids and Bases *continued***PH AND THE ENVIRONMENT**

Living things depend on having a steady pH in their environment. Some plants, such as pine trees, like to grow in acidic soil. The soil has a pH between 4 and 6. Other plants, such as lettuce, need basic soil that has a pH between 8 and 9. Many plants and animals that live in lakes and streams need a neutral pH to survive.

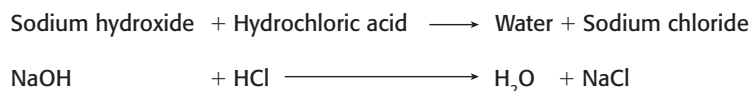
Some plants show different traits with different kinds of soil. For example, the flowers of the hydrangea plant act as a natural indicator. The color of the flowers changes when the plants are grown in soils that have different pH values.

Most rain is slightly acidic and has a pH between 5.5 and 6. Acids form when rainwater reacts with compounds in polluted air, causing the rainwater's pH to decrease. In the United States, most acid rain has a pH between 4 and 4.5. However, some acid rain has a pH as low as 3. Water with low pH can harm fish and other animals.

What Are Salts?

When you hear the word *salt*, you probably think of the table salt you use on your food. However, the sodium chloride in your saltshaker is only one kind of salt. It is one of a large group of compounds called salts.

When an acid neutralizes a base, a salt and water form. A **salt** is an ionic compound. A salt forms when a positive ion from a base combines with a negative ion from an acid. As shown below, sodium hydroxide (NaOH) and hydrochloric acid (HCl) make water (H₂O) and sodium chloride (NaCl). ✓



Salts have many uses. The sodium chloride in food is also used to melt the snow and ice on roads and sidewalks. We use it to make other compounds, including lye and baking soda. The salt calcium sulfate is used to make wallboard for buildings. ✓

STANDARDS CHECK

PS 1b Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals is an example of such a group.

Word Help: chemical of or having to do with properties or actions of substances

Word Help: reaction a response or change

6. Describe Rainwater with a pH below 4.5 would be classified as what kind of rain?

**READING CHECK**

7. Describe How is a salt formed?

**READING CHECK**

8. Name What are two uses of sodium chloride?

Section 3 Review

NSES PS 1b

SECTION VOCABULARY

neutralization reaction the reaction of an acid and a base to form a neutral solution of water and a salt

pH a value that is used to express the acidity or basicity (alkalinity) of a system

salt an ionic compound that forms when a metal atom replaces the hydrogen of an acid

1. Compare What makes an acid a strong acid? What makes a base a weak base?

2. Describe What happens when an acid and a base combine?

3. Complete Fill in the equations below to show the reaction of sodium hydroxide and hydrochloric acid.

Sodium hydroxide + Hydrochloric acid _____ + Sodium chloride

NaOH + HCl _____ + _____

4. Identify What are two ways to measure the pH of a solution?

5. Apply Concepts Soap is made from a strong base and oil. Do you think the pH of soap is 4 or 9? Explain why.

6. Explain A lake has a pH of 3.5. Is it acidic or basic? Would fish be healthy in this lake?

- A strong acid has more molecules that break apart when you dissolve the acid in water than a weak acid does.
- water and a salt
- pH is the amount of hydronium ions in a solution.
- Bases have high pH value, and acids have low pH.
- acid rain
- when a positive ion from a base combines with a negative ion from an acid
- table salt and melting snow and ice

Review

- In water, all the molecules of a strong acid break apart and form hydronium ions. When a weak base is dissolved in water, only a few molecules break off to form hydroxide ions.
- When an acid and base combine, there is a neutralization reaction. The hydrogen ions from the acid combine with the hydroxide ions from the base to form water and a salt.
- Sodium hydroxide + hydrochloric acid → water + sodium chloride
- with pH paper or a pH meter
- The pH would be around 9 because bases have high pH values. The stronger the base, the higher the pH value.
- A pH value below 7 indicates an acid; the lower the number, the more acidic. This would be a bad place for fish to live, because the water is too acidic.

SECTION 4 ORGANIC COMPOUNDS

- two or more carbon atoms linked to one another
- straight chain, branched chain, ring
- organic compounds that contain only carbon and hydrogen
- alkanes, alkenes, and alkynes
- Saturated hydrocarbons have only single covalent bonds between carbon atoms. Unsaturated hydrocarbons have double or triple covalent bonds between carbon atoms.
- carbohydrates, lipids, proteins, nucleic acids
- biochemicals that are made of one or more simple sugar molecules
- biochemicals that do not dissolve in water; store energy

- biochemicals that are made of chains of building blocks called amino acids
- biochemicals made up of nucleotides
- all of the information that a body's cells need to function
- the information that the cell needs to build protein molecules

Review

1. Type of carbon backbone	Description
Ring	The chain of carbon atoms forms a ring.
Straight chain	All carbon atoms are connected in a straight line.
Branched chain	The chain of carbon atoms separates into different directions.

- saturated compounds—alkanes, unsaturated compounds—alkenes and alkynes

3. Type of biochemical	Description
Proteins	made of hundreds or thousands of amino acid molecules
Nucleic acids	one of the functions is to store genetic information
Carbohydrates	made of one or more simple sugar molecules
Lipids	one of the functions is to store energy

- DNA—contains the genetic material of a cell; RNA—contains the information that the cell needs to build protein molecules.

Chapter 16 Atomic Energy

SECTION 1 RADIOACTIVITY

- Energy came from the uranium.
- radioactive decay
- An alpha particle has two protons and two neutrons. Mass number is the sum of the protons and neutrons in a nuclear particle or in a nucleus.
- 224
- mass and charge
- It stays the same.
- 5+
- atoms that have the same number of protons but different number of neutrons
- high-energy waves
- They have more mass and charge, so they tend to interact with atoms more easily.

Review

1. Exothermic reactions give off energy. Endothermic reactions take in energy.
2. Energy is released when a chemical bond forms. Energy is consumed when a chemical bond breaks.
3. Possible answer: exothermic—fire, endothermic—photosynthesis
4. It is an exothermic reaction because the products have less energy than the reactants.
5. Chewing increases surface area of the food.

Chapter 15 Chemical Compounds

SECTION 1 IONIC AND COVALENT COMPOUNDS

1. what happens to the valence electrons
2. Metals form positively charged ions, and nonmetals form negatively charged ions.
3. A crystal lattice is a pattern. Each ion in the pattern bonds to the oppositely charged ions around it.
4. They have strong bonds that hold the ions together.
5. They conduct an electric current because their ions are now free to move past each other.
6. Covalent compounds often are not soluble in water, have low melting points, and form water solutions that don't conduct electricity.

Review

1. Ionic compounds have a much higher melting point than covalent compounds.

2.

Compound	Property	Ionic or covalent
A	low melting point	<u>covalent</u>
B	molecule as smallest particle	<u>covalent</u>
C	water solution that conducts an electric current	<u>ionic</u>
D	high melting point	<u>ionic</u>

3. Ionic compounds break apart easily because they bond together in a pattern called a crystal lattice. If you hit an ionic compound, the ions move and the pattern changes. Ions that have the same charge line up and repel each other.
4. When the crystals dissolve in water, ions become free to move.

5. Each atom of the metal loses one or more electrons to atoms of the nonmetal. The metal atoms form positive ions, and the nonmetal atoms form negative ions. The oppositely charged ions attract, forming ionic bonds.

SECTION 2 ACIDS AND BASES

1. A hydrogen ion bonds with a water molecule to form the hydronium ion.
2. sour taste
3. The left beaker should be colored blue, and the right beaker yellow.
4. hydrogen gas and zinc chloride
5. ions
6. making fertilizers
7. Acids produce hydronium ions, and bases produce hydroxide ions.
8. hydroxide ions
9. It could hurt you because chemicals such as acids and bases can be corrosive or poisonous.
10. The left beaker should be colored pale blue, and the right beaker dark blue.
11. blue
12. household cleaners and fertilizers

Review

1. Acids produce hydronium (H_3O^+) ions, and bases produce hydroxide (OH^-) ions.

2.

Property	Acids	Bases
Taste	<u>sour</u>	<u>bitter</u>
Color change of litmus paper	<u>to red</u>	<u>to blue</u>
Reaction with metals to produce hydrogen gas	<u>yes</u>	<u>no</u>
Electrical conductivity	<u>yes</u>	<u>yes</u>

3. hydronium
4. No, because acids and bases both conduct electricity.
5. It turns blue because ammonia is a base.
6. The acid or base is corrosive.
7. A base; rinse them with lots of water and tell the teacher.

SECTION 3 SOLUTIONS OF ACIDS AND BASES

1. the amount of acid or base dissolved in water