

CHAPTER 3 Chemical Compounds

SECTION

2

Acids and Bases

BEFORE YOU READ

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

- What are the properties of acids?
- What are the properties of bases?

National Science Education Standards
PS 1a, 1b

What Are Acids?

Many of the foods we eat contain acid. Lemons, vinegar, grapes, and soft drinks are examples of *acidic*, or acid-containing foods.

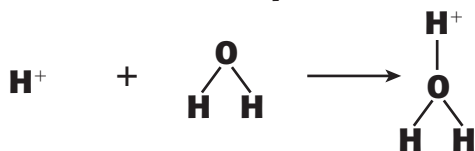


Graphic Organizer In your science notebook, create two Idea Wheels, one about acids and one about bases.



Foods that have a sour taste usually contain acids.

Acids are not just in foods. You can find acid in car batteries, in paper, and even in your stomach. An **acid** is any compound that increases the number of hydronium ions (H_3O^+) when dissolved in water. The figure below shows how the hydronium ion forms.

Formation of a Hydronium Ion

Hydrogen ion plus water make a hydronium ion.

TAKE A LOOK

1. Explain How is a hydronium ion formed?

SECTION 2 Acids and Bases *continued*

What Are the Properties of Acids?

The hydronium ions formed by acids are what give acids their special properties. There are several properties that can tell us that a substance is an acid.

ACIDS HAVE A SOUR TASTE

Have you ever bitten into a lemon? It probably tasted sour and made your mouth pucker up. Foods that have a sour taste usually contain acid. In fact, the word *acid* means “sour” in Latin. The taste of lemons, limes, and other citrus fruits comes from citric acid. ✓

 **READING CHECK**

2. Identify What kind of taste do acids have?

Many acids are dangerous because they are *corrosive*. That means that they destroy body tissue, clothing, and many other things. Most acids are also poisonous. Remember that you should never taste, touch, or smell an unknown chemical.

ACIDS CHANGE THE COLOR OF INDICATORS

We can use colored chemicals to tell us if a solution is an acid or a base. A substance that changes color in the presence of an acid or base is an **indicator**. For example, if you squeeze lemon juice into a cup of tea, the tea changes color. The tea shows that the lemon juice has increased the acidity of the solution.

A solution called *bromthymol blue* is an indicator used by scientists. If you add acid to bromthymol blue, it changes from pale blue to yellow. It *indicates*, or shows, the presence of acid. Scientists also use a special kind of paper called *litmus paper* as an indicator. The paper contains the substance litmus. The paper comes in blue or red. When you add acid to blue litmus paper, the paper turns red.

Detecting Acids with Indicators

The indicator, bromthymol blue, is pale blue in water.

When acid is added, the color changes to yellow because of the presence of the indicator.



TAKE A LOOK

3. Identify Use colored pencils to color the water in the beakers pale blue and yellow.

SECTION 2 Acids and Bases *continued***ACIDS REACT WITH METALS**

Acids react with some metals to make hydrogen gas. For example, when hydrochloric acid reacts with the metal zinc, the product is hydrogen gas. This is the chemical equation for that reaction:

Hydrochloric acid + Zinc \longrightarrow Hydrogen gas + Zinc chloride



In this reaction, zinc takes the place of hydrogen in hydrochloric acid. This reaction happens because zinc is a reactive metal. But other metals, such as silver or gold, do not react easily. For example, if silver were used in the reaction above, no hydrogen gas would be produced.

ACIDS CONDUCT ELECTRICITY

When acids dissolve in water, they break apart and form ions in the solution. The ions make it possible for the solution to conduct an electric current.

A car battery is an example of how an acid can be used to produce an electric current. The acid that is in a car battery conducts an electric current to help start the car's engine.

How Do We Use Acids?

Acids are important chemicals because they have so many uses. Sulfuric acid is the most widely used chemical in the world. It is used to make many products, including paper, paint, and detergents. The sulfuric acid in car batteries conducts the current to help start the car's engine. You can find nitric acid in fertilizers, rubber, and plastic.

Another acid, hydrochloric acid, is used to get metals from their ores. We also put it in swimming pools to keep them free of algae. In addition, hydrochloric acid helps your stomach digest the food you eat.

Food has many kinds of acid in it. For example, orange juice contains citric acid and ascorbic acid (vitamin C). The main ingredient in vinegar is acetic acid. Carbonic acid and phosphoric acid help give soft drinks a sharp taste.

TAKE A LOOK

4. Identify What forms when zinc reacts with hydrochloric acid?

**READING CHECK**

5. Identify What makes it possible for a solution to conduct an electric current?

**READING CHECK**

6. Identify Which of the following uses nitric acid: making paper, making paint, or making fertilizers?

SECTION 2 Acids and Bases *continued***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.

7. Identify What ions are used to group acids and bases?

What Are Bases?

Bases are found in baking powder, chalk, soap, and even the saliva in your mouth. Bases are the opposite of acids. When a base meets an acid, it *neutralizes* it. That means it cancels out acidity. A **base** is any compound that makes many hydroxide ions (OH^-) when it is dissolved in water. For example, sodium hydroxide breaks apart to form sodium ions and hydroxide ions when dissolved in water.

Sodium hydroxide \longrightarrow Sodium ion + Hydroxide ion

$\text{NaOH} \longrightarrow \text{Na}^+ + \text{OH}^-$

Bases, such as a solution of sodium hydroxide, will have many more hydroxide ions than hydronium ions.

What Are the Properties of Bases?

Hydroxide ions give bases their properties. These properties make bases very useful substances. Imagine how dirty we would be without soap and other cleaners made from base compounds.

 **READING CHECK**

8. Describe What gives bases their properties?

Critical Thinking

9. Apply Concepts Why do you think it's a bad idea to use taste, touch, or smell to identify an unknown chemical?

BASES HAVE A BITTER FLAVOR AND FEEL SLIPPERY

The properties of a base solution include a bitter taste and a slippery feel. Have you ever tasted soap? It has a bitter taste. Soap also has the slippery feel of a base.

Never use taste, touch, or smell to identify an unknown chemical. Like acids, many bases are corrosive. If you use a base in an experiment, be very careful. If your fingers feel slippery, you may have gotten the base on your hands. You should quickly rinse your hand with large amounts of water and tell your teacher.

BASES CHANGE THE COLOR OF INDICATORS

Like acids, bases change the color of an indicator. Bases turn most indicators a different color than acids do. For example, bases change the color of red litmus paper to blue. Bromthymol blue turns a darker blue when you add a base to it.

SECTION 2 Acids and Bases *continued***Detecting Bases with Indicators**

The indicator, bromthymol blue, is pale blue in water.



When a base is added to the indicator, the indicator turns dark blue.

**TAKE A LOOK**

10. Identify Use colored pencils to color the water in the beakers pale blue and dark blue.

BASES CONDUCT AN ELECTRIC CURRENT

Like acids, solutions of bases conduct an electric current. Bases are good conductors because they contain many hydroxide ions (OH^-).



Soaps are made by using sodium hydroxide, which is a base. Soaps remove dirt and oils from skin and feel slippery when you touch them.



Baking soda is a mild base. It is used in toothpastes to neutralize acids, which can produce unpleasant odors.

TAKE A LOOK

11. Identify What color will baking soda turn litmus paper?

How Are Bases Used?

Like acids, bases have many uses. Companies use the base sodium hydroxide to make soap and paper. It is also used in oven cleaners and in products that unclog drains. Ammonia is found in many household cleaners and is used to make fertilizers. The antacids people use to treat heartburn contain magnesium hydroxide and aluminum hydroxide. ✓

READING CHECK

12. Identify What are two products that contain ammonia?

Section 2 Review

NSES PS 1a, 1b

SECTION VOCABULARY

acid any compound that increases the number of hydronium ions when dissolved in water**base** any compound that increases the number of hydroxide ions when dissolved in water**indicator** a compound that can reversibly change color depending on conditions such as pH

- 1. Explain** What kind of ions do acids produce when you dissolve them in water? What kind of ions do bases produce?

- 2. Graphic Organizer** Fill in the table below with the properties of acids and bases. Draw lines between the properties that are the same.

| Property | Acids | Bases |
|--|-------|-------|
| Taste | | |
| Color change of litmus paper | | |
| Reaction with metals to produce hydrogen gas | | |
| Electrical conductivity | | |

- 3. Applying Concepts** Lemon juice is an acid. What ion is present in lemon juice that makes it an acid?

- 4. Evaluating Data** A solution conducts electric current. Can you use this property to determine if the solution is an acid or a base? Explain.

- 5. Describe** What happens to red litmus paper when it touches a household cleaner that has ammonia in it, and why?

- 6. Identify** What word is used to describe an acid or base that can destroy body tissue, clothing, and many other things?

- 7. Identify** Suppose you are doing an experiment and your fingers feel slippery; what did you probably get on them? What should you do if this happens to you?

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 | sour | bitter |
| Color change of litmus paper | to red | to blue |
| Reaction with metals to produce hydrogen gas | yes | no |
| Electrical conductivity | yes | yes |

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
2. A strong acid has more molecules that break apart when you dissolve the acid in water than a weak acid does.
3. water and a salt

4. pH is the amount of hydronium ions in a solution.
5. Bases have high pH value, and acids have low pH.
6. acid rain
7. when a positive ion from a base combines with a negative ion from an acid
8. table salt and melting snow and ice

Review

1. 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.
2. 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.
3. Sodium hydroxide + hydrochloric acid \rightarrow water + sodium chloride
4. with pH paper or a pH meter
5. The pH would be around 9 because bases have high pH values. The stronger the base, the higher the pH value.
6. 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

1. two or more carbon atoms linked to one another
2. straight chain, branched chain, ring
3. organic compounds that contain only carbon and hydrogen
4. alkanes, alkenes, and alkynes
5. Saturated hydrocarbons have only single covalent bonds between carbon atoms. Unsaturated hydrocarbons have double or triple covalent bonds between carbon atoms.
6. carbohydrates, lipids, proteins, nucleic acids
7. biochemicals that are made of one or more simple sugar molecules
8. biochemicals that do not dissolve in water; store energy
9. biochemicals that are made of chains of building blocks called amino acids
10. biochemicals made up of nucleotides
11. all of the information that a body's cells need to function