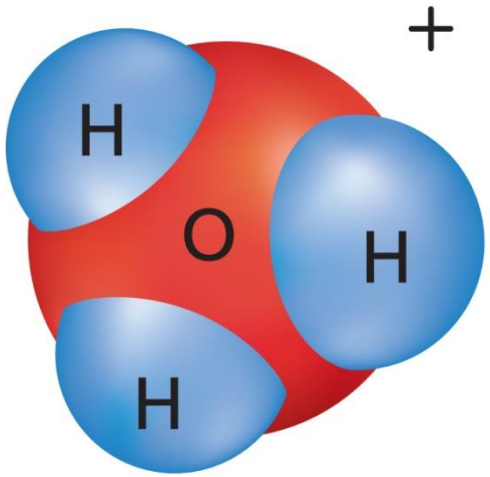
Chapter Menu



What are solutions, and how are they described?

Get Ready

What do you think?

Before you begin, decide if you agree or disagree with each of these statements. As you view this presentation, see if you change your mind about any of the statements.

Get Ready

Do you agree or disagree?

1. You can identify a mixture by looking at it without magnification.
2. A solution is another name for a homogeneous mixture.
3. Solutions can be solids, liquids, or gases.

Get Ready

Do you agree or disagree?

4. A teaspoon of soup is less concentrated than a cup of the same soup.

5. Acids are found in many foods.

6. You can determine the exact pH of a solution by using pH paper.

Lesson 1

Substances and Mixtures

Key Concepts 

- How do substances and mixtures differ?
- How do solutions compare and contrast with heterogeneous mixtures?
- In what three ways do compounds differ from mixtures?

Lesson 1

Substances and Mixtures

Vocabulary

- substance
- mixture
- heterogeneous mixture
- homogeneous mixture
- solution

Matter: Substances and Mixtures

- Nearly all types of matter can be sorted into just two major categories—substances and mixtures.
- A **substance** is matter that is always made up of the same combination of atoms.
- A compound is matter made of atoms of two or more elements chemically bonded together.

Matter: Substances and Mixtures (cont.)

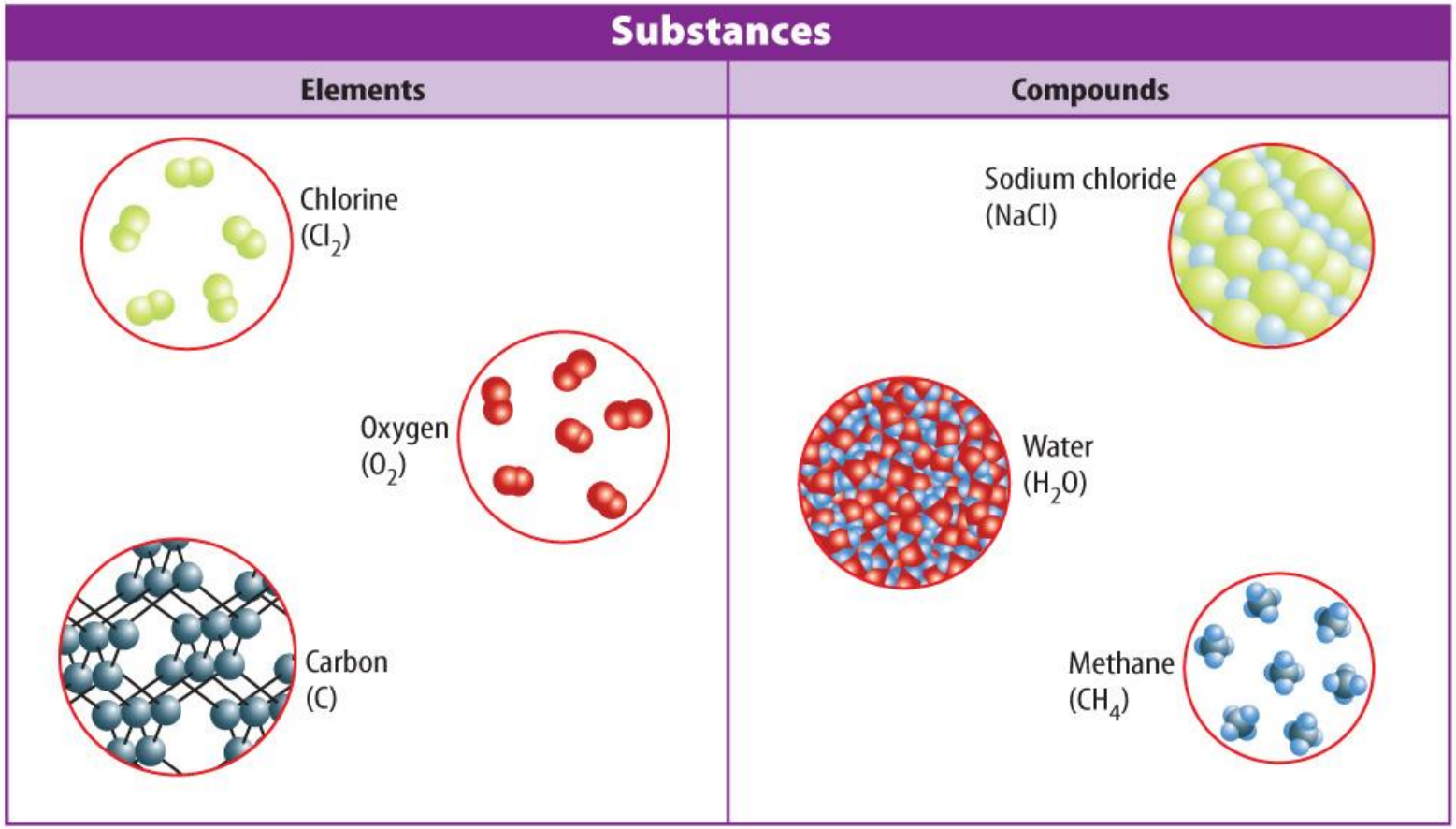
Science Use v. Common Use

substance

Science Use matter that is always made of the same combination of atoms

Common Use any physical material from which something is made

There are two types of substances—elements and compounds.



Matter: Substances and Mixtures (cont.)

- A **mixture** is two or more substances that are physically blended but are not chemically bonded together.
- The amounts of each substance in a mixture can vary.
- There are two different types of mixtures—heterogeneous and homogeneous.

Matter: Substances and Mixtures (cont.)

KEY CONCEPT CHECK

How do substances and mixtures differ?

Matter: Substances and Mixtures (cont.)

- A **heterogeneous mixture** is a mixture in which substances are not evenly mixed.
- A **homogeneous mixture** is a mixture in which two or more substances are evenly mixed on the atomic level but not bonded together.
- Another name for a homogeneous mixture is **solution**.

Matter: Substances and Mixtures (cont.)

Key Concept Check

How can you determine whether a mixture is homogeneous or heterogeneous?

Matter: Substances and Mixtures (cont.)

WORD ORIGIN

heterogeneous

from Greek *heteros*, means "different"; and *genos*, means "kind"

homogeneous

from Greek *homos*, means "same"; and *genos*, means "kind"

How do compounds and mixtures differ?

- Because substances that make up a mixture are not changed chemically, some of their properties are observed in the mixture.
- The properties of a compound can be different from the properties of the elements that make it up.

How do compounds and mixtures differ? (cont.)

- Because the substances that make up a mixture are not bonded together, they can be separated from each other using physical methods.
- The difference in physical properties, such as boiling points, of substances can be used to separate the substances.

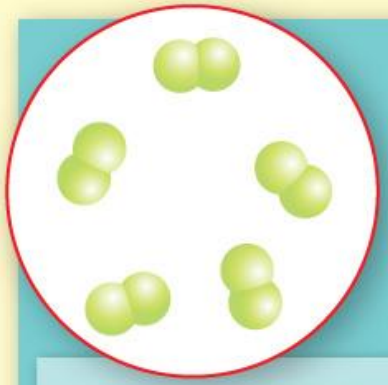
How do compounds and mixtures differ? (cont.)

Key Concept Check

In what three ways do compounds differ from mixtures?

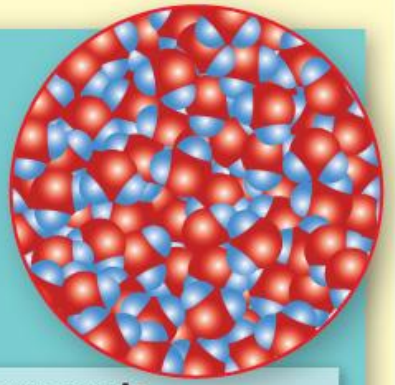
Matter

- anything that has mass and takes up space
- Most matter on Earth is made up of atoms.



Substances

- matter with a composition that is always the same
- two types of substances: elements and compounds



Elements

- consist of just one type of atom
- organized on the periodic table
- Elements can exist as single atoms or as diatomic molecules—two atoms bonded together.

Chemical changes

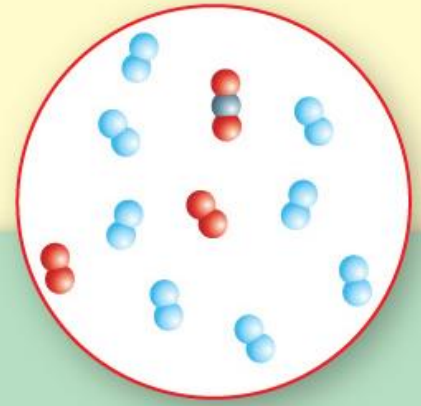
Compounds

- two or more types of atoms bonded together
- can't be separated by physical methods
- Properties of a compound are different from the properties of the elements that make it up.
- two types: ionic and covalent

Separating mixtures
- filtering
- boiling
- using a magnet

Physical changes

Combining substances
- mixing
- dissolving



Mixtures

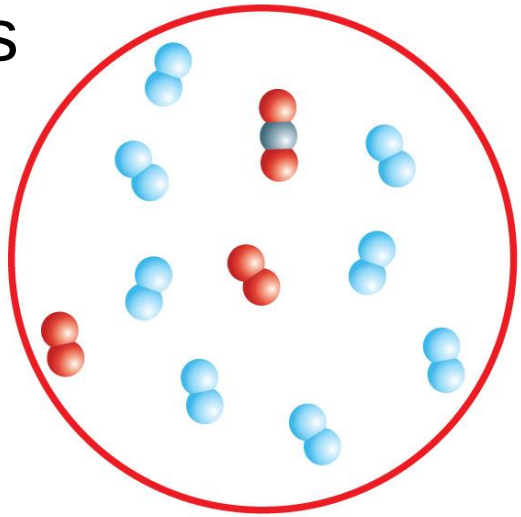
- matter that can vary in composition
- made of two or more substances mixed but not bonded together
- can be separated into substances by physical methods
- two types of mixtures: heterogeneous and homogeneous

Heterogeneous mixtures
- two or more substances unevenly mixed
- Uneven mixing is visible with unaided eyes or a microscope.

Homogeneous mixtures (solutions)
- two or more substances evenly mixed
- Homogeneous mixtures appear uniform under a microscope.

Summary

- Substances have a composition that does not change. The composition of mixtures can vary.
- Solutions (homogeneous mixtures) are mixed at the atomic level.



Summary

- Mixtures contain parts that are not bonded together. These parts can be separated using physical means.

Lesson Review

What are the two types of substances?

A. mixtures and compounds

B. mixtures and solutions

C. elements and compounds

D. elements and solutions

Lesson Review

Which term refers to a mixture in which substances are not evenly mixed?

A. heterogeneous mixture

B. homogeneous mixture

C. solution

D. compound

Lesson Review

How can substances that make up a mixture be separated?

A. by using chemical changes

B. by using chemical properties

C. by using physical changes

D. by using physical properties

Lesson Review

What do you think NOW?

Do you agree or disagree?

1. You can identify a mixture by looking at it without magnification.
2. A solution is another name for a homogeneous mixture.

Lesson 2

Properties of Solutions

Key Concepts 

- Why do some substances dissolve in water and others do not?
- How do concentration and solubility differ?
- How can the solubility of a solute be changed?

Lesson 2

Properties of Solutions

Vocabulary

- solvent
- solute
- polar molecule
- concentration
- solubility
- saturated solution
- unsaturated solution

Parts of Solutions

- The **solvent** is the substance that exists in the greatest quantity in a solution.
- All other substances in a solution are **solutes**.

Types of Solutions

- Solutions can exist in all three states of matter—solid, liquid, or gas.
- The state of the solvent, because it exists in the greatest quantity, determines the state of the solution

Types of Solutions

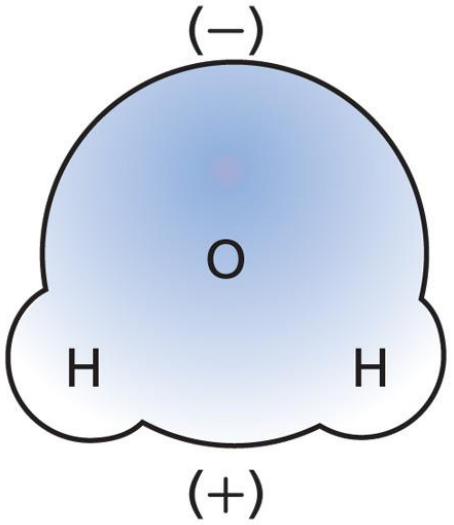
State of Solution	Solvent Is:	Solute Can Be:
Solid	solid	**gas or solid (called alloys)** A saxophone is a solid solution of solid copper and solid zinc.
Liquid	liquid	**solid, liquid, and/or gas** Soda is a liquid solution of liquid water, gaseous carbon dioxide, and solid sugar and other flavorings.
Gas	gas	**gas** A lighted sign contains a gaseous mixture of gaseous argon and gaseous mercury.

Water as a Solvent

- Water is one of the few substances on Earth that exists naturally in all three states—solid, liquid, and gas.
- In nature, water almost always exists as a solution; it contains dissolved solutes.
- A water molecule is a covalent compound.

- Water is a **polar molecule**—a molecule with a slightly negative end and a slightly positive end.
- Nonpolar molecules have an even distribution of charge.

The electrons spend more time near the oxygen atom. This makes the end with the oxygen atom slightly negative (–).



The end with the hydrogen atoms is slightly positive (+).

Like Dissolves Like

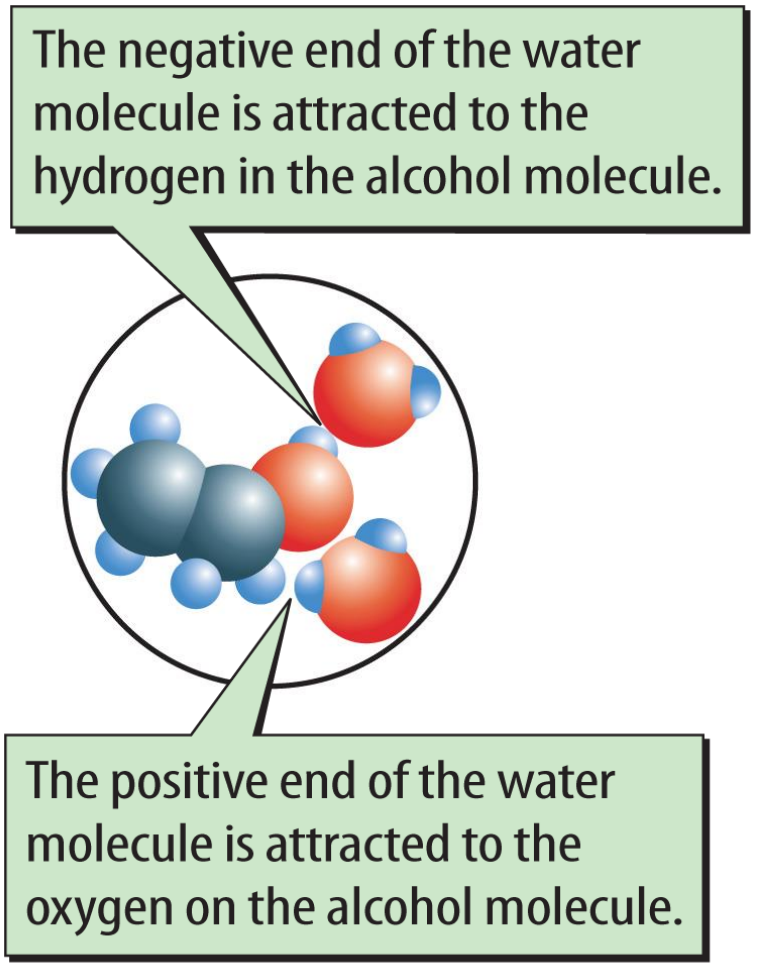
- Water is often called the universal solvent because it dissolves many different substances.
- Polar solvents dissolve polar solutes easily. Nonpolar solvents dissolve nonpolar solutes easily.
- Because water is a polar solvent, it dissolves most polar and ionic solutes.

Like Dissolves Like (cont.)

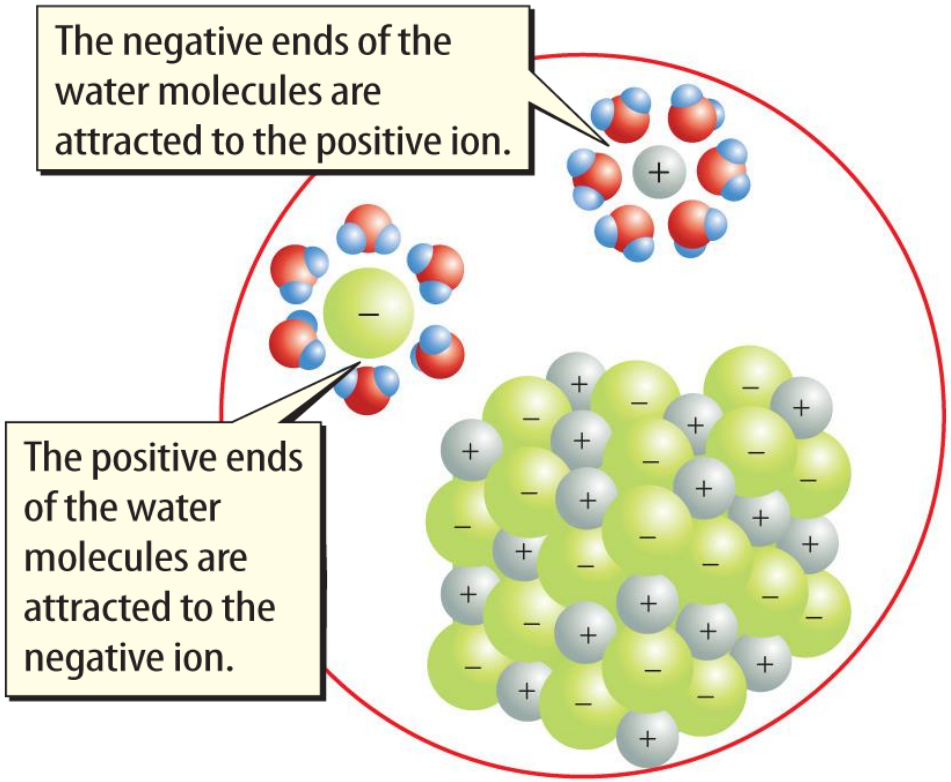
KEY CONCEPT CHECK

Why do some substances dissolve in water and others do not?

When a polar solute, such as rubbing alcohol, dissolves in a polar solvent, such as water, the poles of the solvent are attracted to the oppositely charged poles of the solute.



- When ionic solutes dissolve, the positive poles of the solvent are attracted to the negative ions.
- The negative poles of the solvent are attracted to the positive ions.



Concentration—How much is dissolved?

- **Concentration** is the amount of a particular solute in a given amount of solution.
- The terms *concentrated* and *dilute* are one way to describe how much solute is dissolved in a solution.

Concentration—How much is dissolved? (cont.)

To calculate concentration, you must know both the mass of solute and the volume of solution that contains this mass, and then, divide the mass of solute by the volume of solution.

$$\text{Concentration } (C) = \frac{\text{mass of solute } (m)}{\text{volume of solution } (V)}$$

Math Skills — Calculate Concentration

Solve for Concentration Suppose you want to calculate the concentration of salt in a **0.4 L** can of soup. The back of the can says it contains **1.6 g** of salt. What is its concentration in g/L? In other words, how much salt would be contained in 1 L of soup?

1. **This is what you know:** mass: **1.6 g**; volume: **0.4 L**
2. **This is what you need to find:** concentration: C
3. **Use this formula:** $C = \frac{m}{V}$
4. **Substitute:** $C = \frac{\mathbf{1.6\ g}}{\mathbf{0.4\ L}} = 4\ \text{g/L}$

   the values for m and V

   into the formula and divide.

Answer: The concentration is 4 g/L. As you might expect, 0.4 L of soup contains less salt (1.6 g) than 1 L of soup (4 g). However, the concentration of both amounts of soup is the same—4 g/L.

Concentration—How much is dissolved? (cont.)

- If a solution contains only liquids or gases, its concentration is stated as the volume of solute in a given volume of solution.
- Percent by volume is calculated by dividing the volume of the solute by the total volume of solution and then multiplying the quotient by 100.

Solubility—How much can dissolve?

Solubility is the maximum amount of solute that can dissolve in a given amount of solvent at a given temperature and pressure.

WORD ORIGIN

solubility

from Latin *solvere*, means "to loosen"

Solubility—How much can dissolve?

(cont.)

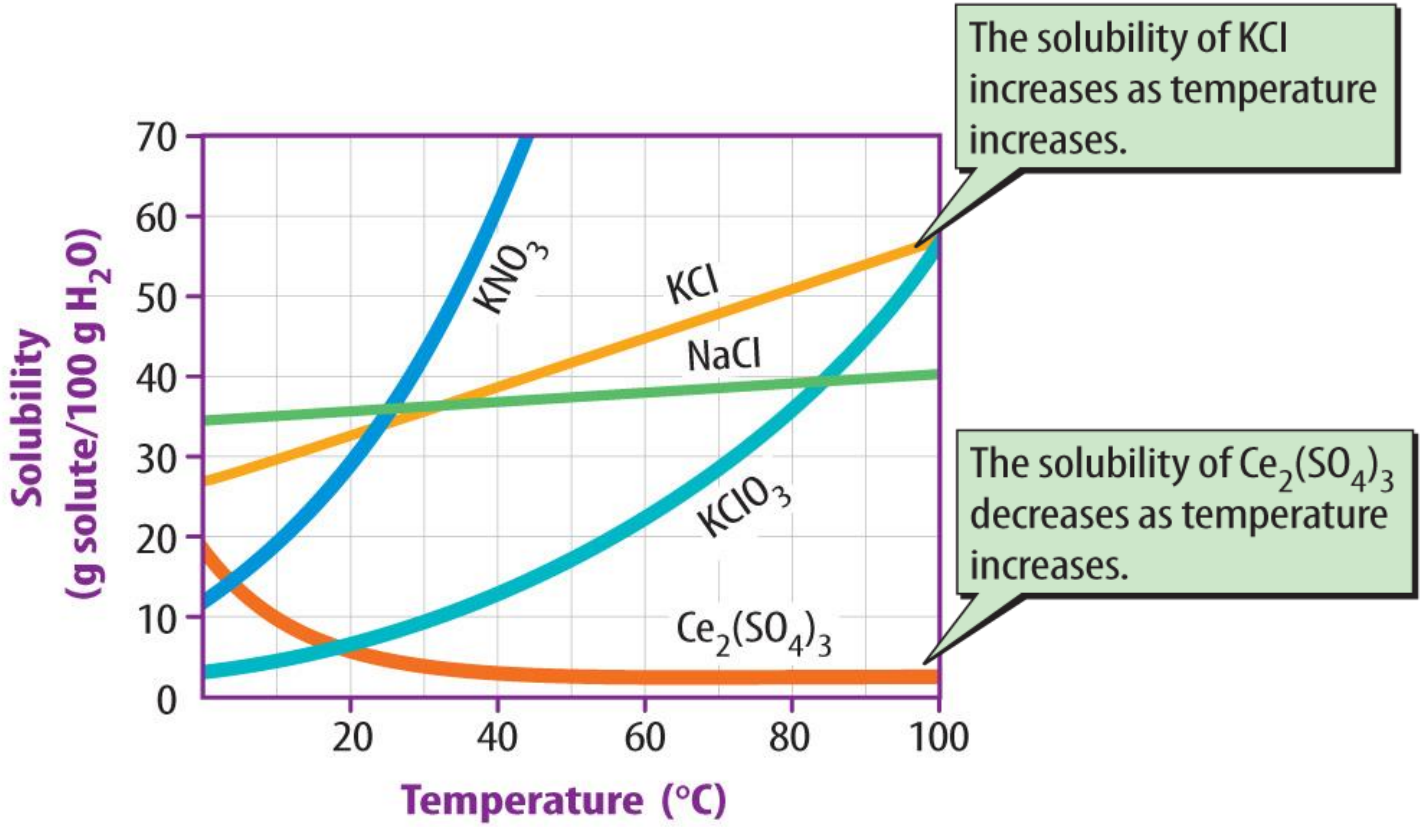
Key Concept Check

How do concentration and solubility differ?

Solubility—How much can dissolve? (cont.)

- If a substance has a high solubility, more of it can dissolve in a given solvent.
- A **saturated solution** is a solution that contains the maximum amount of solute the solution can hold at a given temperature and pressure.
- An **unsaturated solution** is a solution that can still dissolve more solute at a given temperature and pressure.

Changing either temperature or pressure changes how much solute can dissolve in a solvent.



Solubility—How much can dissolve?

(cont.)

Key Concept Check

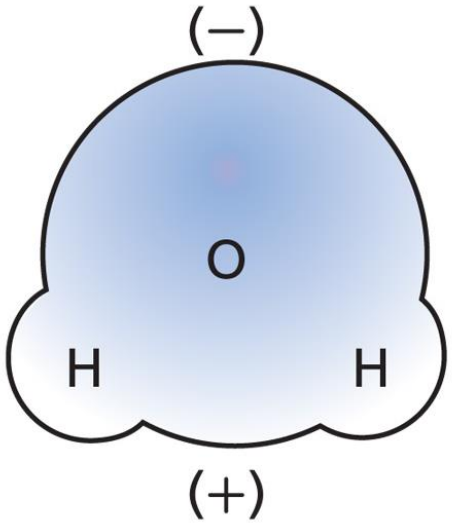
How can the solubility of a solute be changed?

How Fast a Solute Dissolves

- If solute and solvent particles come into contact more often, the solute dissolves faster.
- Stirring a solution, crushing the solute, and increasing the temperature are three ways to increase how often solute particles contact solvent particles.

Summary

- Substances dissolve in other substances that have similar polarity. In other words, like dissolves like.



Summary

- Concentration is the amount of substance that is dissolved. Solubility is the maximum amount that can dissolve.
- Both temperature and pressure affect the solubility of solutes in solutions.

Lesson Review

Which refers to a molecule with a slightly negative end and a slightly positive end?

A. concentrated molecule

B. nonpolar molecule

C. polar molecule

D. saturated molecule

Lesson Review

Which term refers to a solution that can still dissolve more solute at a given temperature and pressure?

A. unsaturated solution

B. saturated solution

C. polar solution

D. concentrated solution

Lesson Review

A solid might become less soluble in a liquid when you decrease what?

A. particle size

B. pressure

C. temperature

D. stirring

Lesson Review

What do you think NOW?

Do you agree or disagree?

3. Solutions can be solids, liquids, or gases.
4. A teaspoon of soup is less concentrated than a cup of the same soup.

Lesson 3

Acid and Base Solutions

Key Concepts

- What happens when acids and bases dissolve in water?
- How does the concentration of hydronium ions affect pH?
- What methods can be used to measure pH?

Lesson 3

Acid and Base Solutions

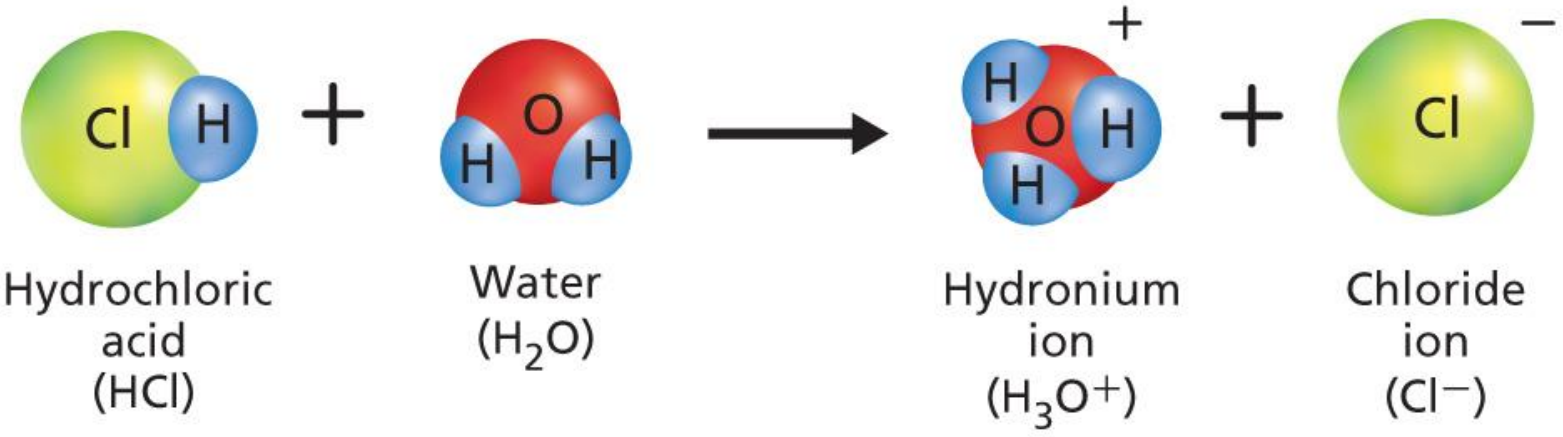
Vocabulary

- acid
- hydronium ion
- base
- pH
- indicator

What are acids and bases?

- An **acid** is a substance that produces a hydronium ion (H_3O^+) when dissolved in water.
- Nearly all acid molecules contain one or more hydrogen atoms.
- A **hydronium ion**, H_3O^+, is a positively charged ion formed when an acid dissolves in water.

When an acid mixes with water, the hydrogen atom separates from the acid and quickly combines with a water molecule, resulting in a hydronium ion.



Hydrochloric acid (HCl)

Water (H_2O)

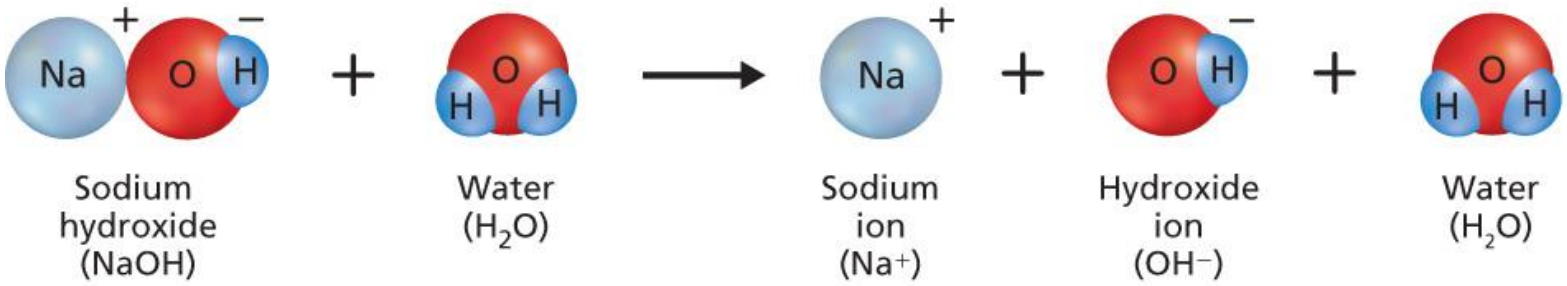
Hydronium ion (H_3O^+)

Chloride ion (Cl^-)

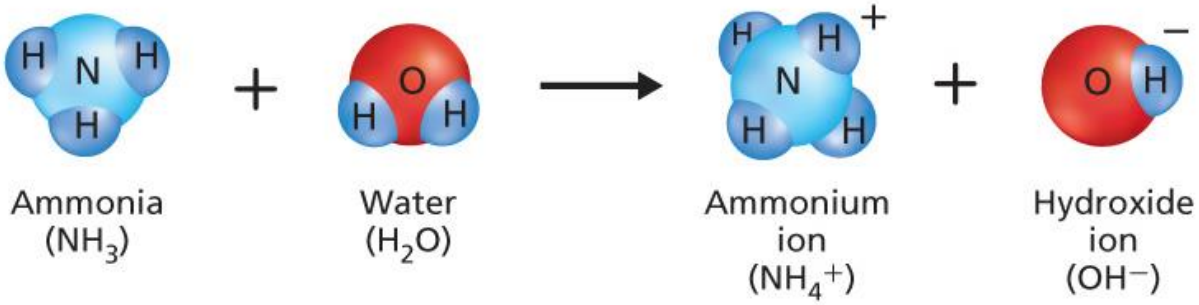
What are acids and bases? (cont.)

- A **base** is a substance that produces hydroxide ions (OH^-) when dissolved in water.
- When a hydroxide compound mixes with water, hydroxide ions separate from the base and form hydroxide ions in water.

When a hydroxide compound mixes with water, hydroxide ions separate from the base and form hydroxide ions in water.



Bases that do not contain hydroxide ions produce hydroxide ions by taking hydrogen atoms away from water, leaving hydroxide ions.

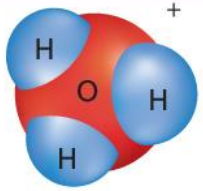
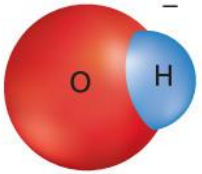


What are acids and bases? (cont.)

KEY CONCEPT CHECK

What happens when acids and bases dissolve in water?

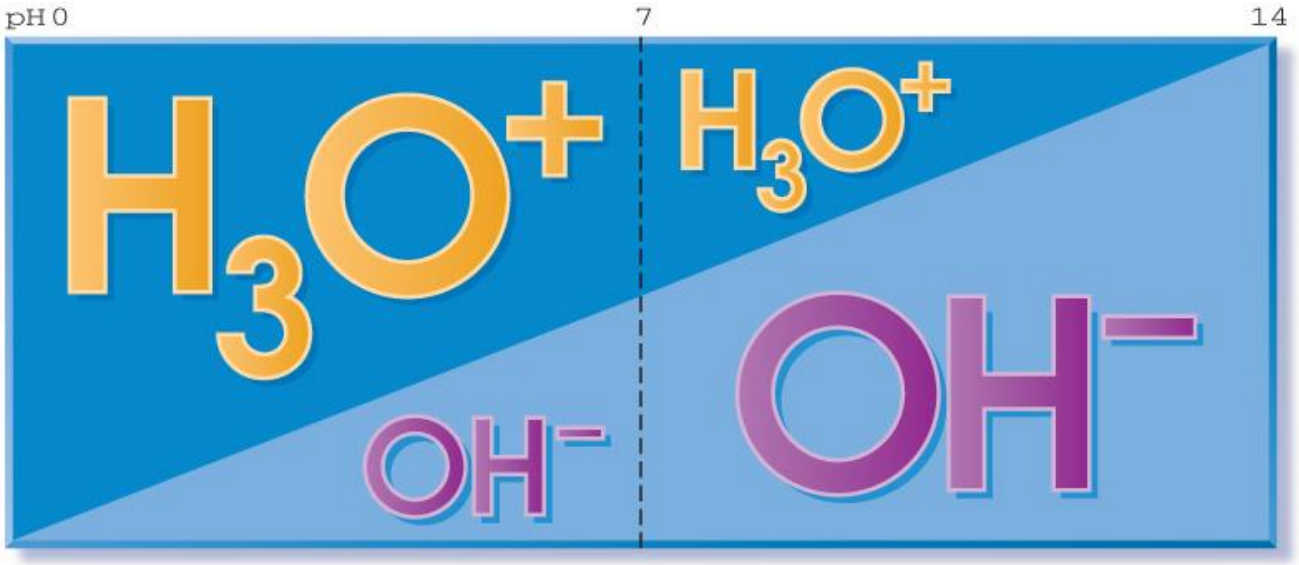
Properties and Uses of Acids and Bases

	Acids	Bases
Ions produced	 Acids produce H_3O^+ in water.	 Bases produce OH^- ions in water.
Examples	• hydrochloric acid, HCl • acetic acid, CH_3COOH • citric acid, $H_3C_6H_5O_7$ • lactic acid, $C_3H_6O_3$	• sodium hydroxide, NaOH • ammonia, NH_3 • sodium carbonate, Na_2CO_3 • calcium hydroxide, $Ca(OH)_2$
Some properties	• Acids provide the sour taste in food (never taste acids in the laboratory). • Most can damage skin and eyes. • Acids react with some metals to produce hydrogen gas. • H_3O^+ ions can conduct electricity in water. • Acids react with bases to form neutral solutions.	• Bases provide the bitter taste in food (never taste bases in the laboratory). • Most can damage skin and eyes. • Bases are slippery when mixed with water. • OH^- ions can conduct electricity in water. • Bases react with acids to form neutral solutions.
Some uses	• Acids are responsible for natural and artificial flavoring in foods, such as fruits. • Lactic acid is found in milk. • Acid in your stomach breaks down food. • Blueberries, strawberries, and many vegetable crops grow better in acidic soil. • Acids are used to make products such as fertilizers, detergents, and plastics.	• Bases are found in natural and artificial flavorings in food, such as cocoa beans. • Antacids neutralize stomach acid, alleviating heartburn. • Bases are found in cleaners such as shampoo, dish detergent, and window cleaner. • Many flowers grow better in basic soil. • Bases are used to make products such as rayon and paper.

What is pH?

- The **pH** is an inverse measure of the concentration of hydronium ions (H_3O^+) in a solution.
- A solution with a lower pH is more acidic.

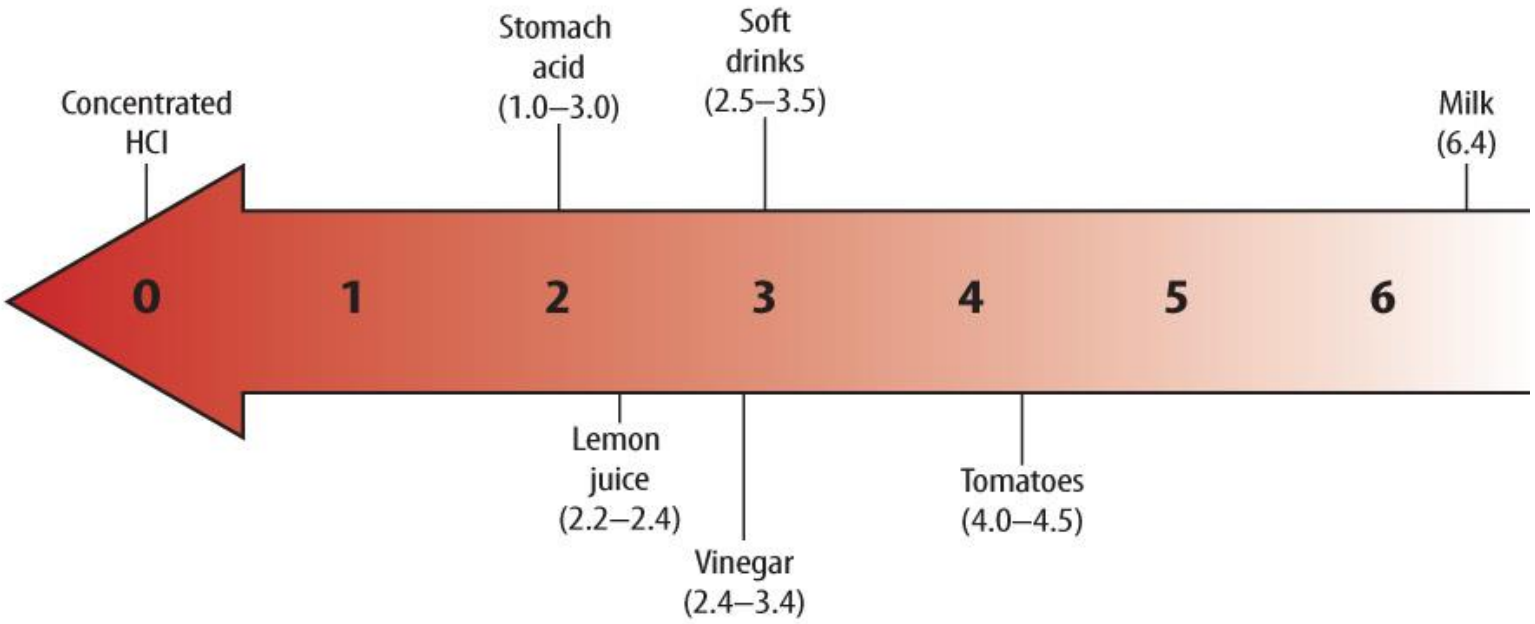
As the concentration of hydronium ions decrease, the pH increases.



What is pH? (cont.)

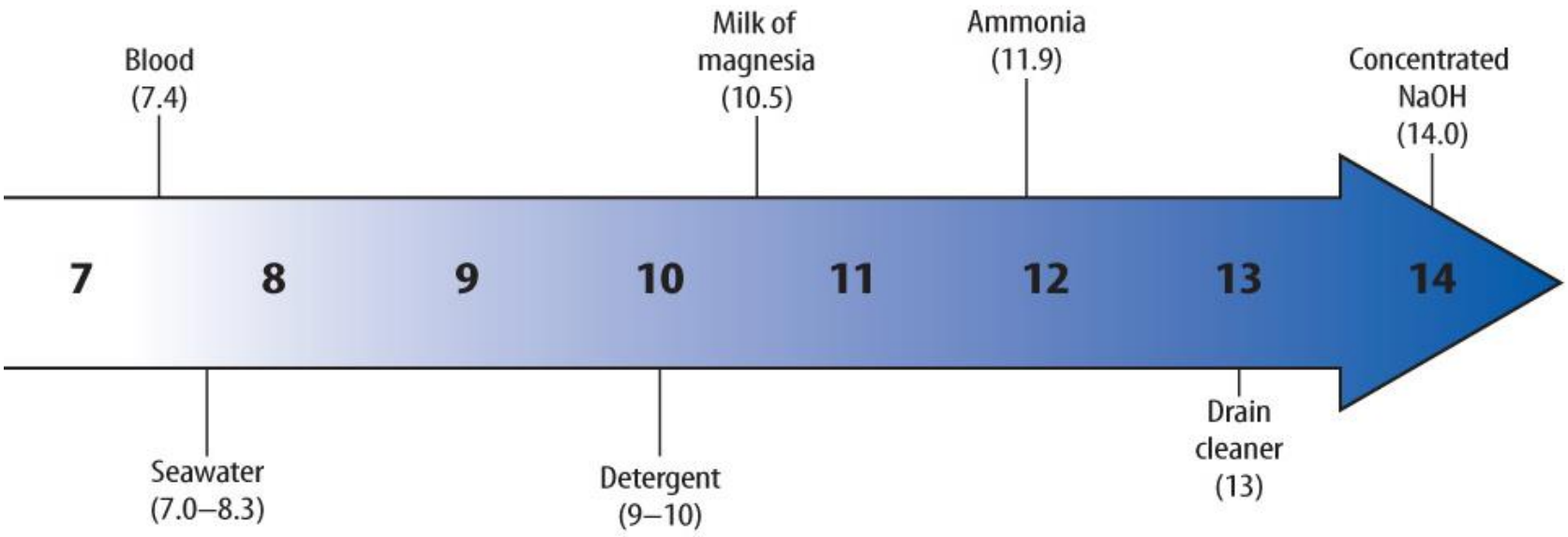
- All acid and base solutions contain both hydronium and hydroxide ions.
- In a neutral solution, such as water, the concentrations of hydronium and hydroxide ions are equal.
- Acids have a greater concentration of hydronium ions than hydroxide ions.
- Bases have a greater concentration of hydroxide ions than hydronium ions.

The pH scale helps classify solutions as acidic or basic.



Get Animated

The pH scale helps classify solutions as acidic or basic.



What is pH? (cont.)

Key Concept Check

How does the concentration of hydronium ions affect pH?

What is pH? (cont.)

- The pH scale is used to indicate how acidic or basic a solution is.
- The pH scale contains values that range from below 0 to above 14.
- On the pH scale acids have a pH below 7.
- Bases have a pH above 7.

What is pH? (cont.)

- Solutions that are neutral have a pH of 7—they are neither acidic nor basic.
- A change in one pH unit represents a tenfold change in the acidity or basicity of a solution.

How is pH measured?

- An **indicator** is a compound that changes color at different pH values when it reacts with acidic or basic solutions.
- There are many different indicators—each indicator changes color over a specific range of pH values.

How is pH measured? (cont.)

- The pH of a solution can be measured by dipping a pH testing strip into the solution.
- A more accurate way to measure pH is to use a pH meter.

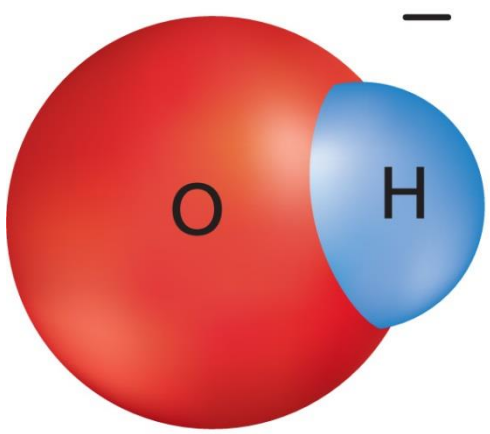
How is pH measured? (cont.)

Key Concept Check

What are two methods that can be used to measure the pH of a solution?

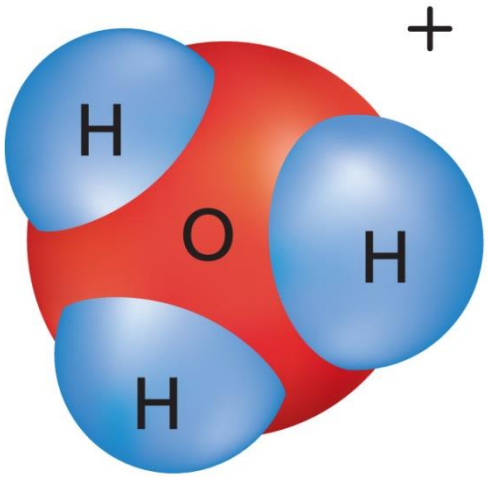
Summary

- Acids contain hydrogen ions that are released and form hydronium ions in water. Bases are substances that form hydroxide ions when dissolved in water.



Summary

- Hydronium ion concentration changes inversely with pH. This means that as hydronium ion concentration increases, the pH decreases.



Summary

- pH can be measured using indicators or digital pH meters.

Lesson Review

Which substance produces hydroxide ions when dissolved in water?

A. acetic acid

B. ammonia

C. hydrochloric acid

D. lactic acid

Lesson Review

One solution has a pH of 2. Another solution has a pH of 5. What is the difference in acidity?

A. 3

B. 10

C. 100

D. 1000

Lesson Review

Which term describes a compound that changes color at different pH values when it reacts with acidic or basic solutions?

A. base

B. acid

C. hydroxide ion

D. indicator

Lesson Review

What do you think NOW?

Do you agree or disagree?

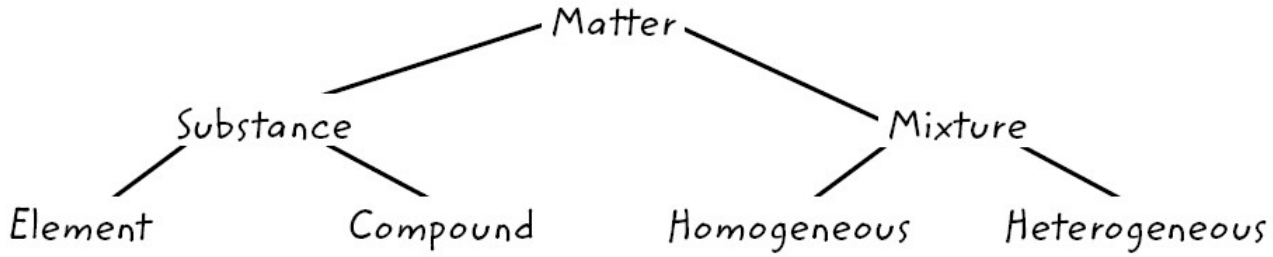
5. Acids are found in many foods.
6. You can determine the exact pH of a solution by using pH paper.

Menu

Mixtures and substances are the two main classifications of matter. A solution is a type of mixture. Solutions can be described by the concentration and type of solute they contain.

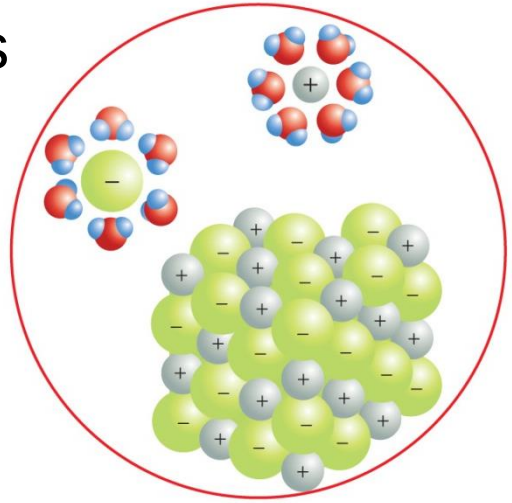
Lesson 1: Substances and Mixtures

- Substances have a fixed composition. The composition of mixtures can vary.
- Solutions and heterogeneous mixtures are both types of mixtures. Solutions are mixed at the atomic level.
- Mixtures contain parts that are not bonded together. These parts can be separated using physical means, and their properties can be seen in the solution.



Lesson 2: Properties of Solutions

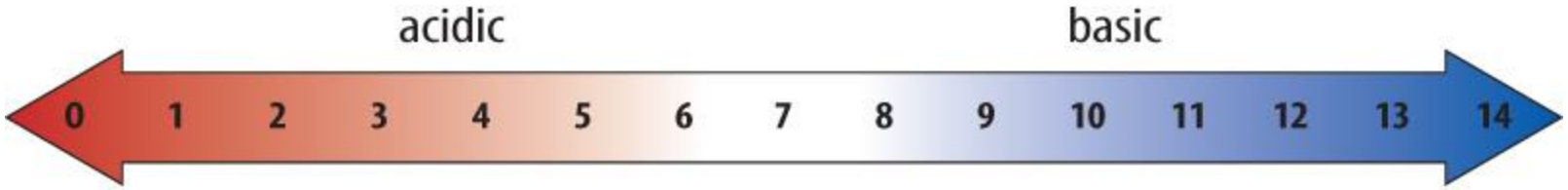
- Substances dissolve other substances that have a similar polarity. In other words, like dissolves like.
- Concentration is the amount of a solute that is dissolved. Solubility is the maximum amount of a solute that can dissolve.



- Both temperature and pressure affect the solubility of solutes in solutions.

Lesson 3: Acid and Base Solutions

- Acids contain hydrogen ions that are released and form hydronium ions in water. Bases are substances that form hydroxide ions when dissolved in water.
- Hydronium ion concentration changes inversely with pH. This means that as hydronium ion concentration increases, the pH decreases.
- pH can be measured using indicators or digital pH meters.



Chapter Review

What term describes matter that is always made up of the same combination of atoms?

A. compound

B. mixture

C. solution

D. substance

Chapter Review

What is another name for a homogeneous mixture?

A. heterogeneous mixture

B. solute

C. solution

D. substance

Chapter Review

Which describes the amount of a particular solute in a given amount of solution?

A. saturation

B. solvent

C. solubility

D. concentration

Chapter Review

When iodine is dissolved in alcohol, what term is used to describe the alcohol?

A. concentrate

B. solvent

C. solution

D. solute

Chapter Review

Which is an inverse measure of the concentration of hydronium ions in a solution?

A. acid

B. base

C. indicator

D. pH

Standardized Test Practice

Which term refers to two or more substances that are physically blended but are not chemically bonded together?

A. compound

B. element

C. mixture

D. solute

Standardized Test Practice

Which term refers to a mixture in which two or more substances are evenly mixed on the atomic level but not bonded together?

A. homogeneous mixture

B. heterogeneous mixture

C. element

D. compound

Standardized Test Practice

Which term refers to the maximum amount of solute that can dissolve in a given amount of solvent at a given temperature and pressure?

A. concentration

B. nonpolar

C. polar

D. solubility

Standardized Test Practice

What term refers to a solution that contains the maximum amount of solute the solution can hold at a given temperature and pressure?

A. unsaturated solution

B. saturated solution

C. homogeneous mixture

D. heterogeneous mixture

Standardized Test Practice

Which describes a positively charged ion formed when an acid dissolves in water?

A. hydroxide ion

B. hydronium ion

C. base

D. acid