chapter 8

Substances, Mixtures, and Solubility

section 1 What is a solution?

What You'll Learn

- the differences between substances and mixtures
- two types of mixtures
- how solutions form
- different types of solutions

Before You Read

Do you add sugar to your tea? How do you know that the white substance will make your drink sweeter?

Read to Learn

Substances

Water, salt water, and pulpy orange juice are different liquids. Their differences can be explained by chemistry. Think about pure water. If you freeze it, melt it, or boil it, it is still water. But, if you boil salt water, the water turns to gas and leaves the salt behind. If you strain pulpy orange juice, it loses its pulp. How does chemistry explain these differences? The answer has to do with the chemical makeup of these materials.

What are atoms, substances, and elements?

Atoms Recall that atoms are the basic building block of matter. Each atom has its own chemical and physical properties. These properties are determined by the number of protons the atom has.

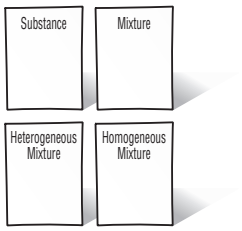
Substances A **substance** is matter that has the same fixed makeup and properties throughout. A substance cannot be broken down into simpler parts by a physical process. For example, you can freeze, boil, stir, and filter water, but it is still water. The only way to change a substance is by a chemical process. The table on the next page shows some examples of physical processes and chemical processes.

Mark the Text

Underline As you read, underline words and sentences that you think are important to remember. After you read, review what you have underlined.

FOLDABLES™

A Classify Use quarter-sheets of paper to help you organize definitions and examples of substances and mixtures.



Picture This

1. **Explain** How do physical processes differ from chemical processes?

Think it Over

2. **Classify** Why is water a compound and not an element?

Examples of Physical and Chemical Processes

Physical Processes (do not change substances)	Chemical Processes (do change substances)
Boiling	Burning
Changing pressure	Reacting with other chemicals
Cooling	Reacting with light
Sorting	

Elements An element is an example of a pure substance. An element cannot be broken down into simpler substances. The number of protons in an element cannot change unless the element changes.

What are compounds?

Water is a compound. A compound is a substance made of two or more elements that are chemically combined. The makeup of a compound is always the same. For example, a water molecule always has two hydrogen atoms combined with one oxygen atom. All water, whether frozen, liquid, or vapor, has the same ratio of hydrogen atoms to oxygen atoms.

Mixtures

Imagine drinking a glass of salt water. You would know right away that it is not pure water. Salt water is not a pure substance. It is a mixture of salt and water. Mixtures are made when two or more substances come together but do not chemically bond together to make a new substance. The substances can be separated by physical processes. For example, you can boil salt water to separate the salt from the water.

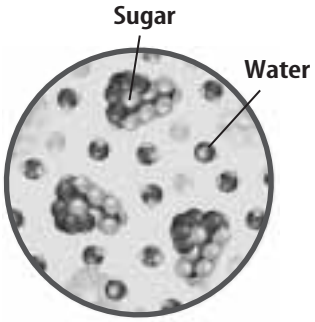
Mixtures do not contain an exact amount of each substance like a compound. Lemonade can be weak tasting or strong tasting. It depends on how much lemon juice is added to the water. It also can be sweet or sour, depending on how much sugar is added. No matter how strong, weak, sweet, or sour, it is still lemonade.

What are heterogeneous mixtures?

Some mixtures are easy to see. A watermelon is a mixture of fruit and seeds. But, the fruit and seeds aren't mixed evenly. A **heterogeneous** (he tuh ruh JEE nee us) **mixture** is a mixture where the substances are not mixed evenly. The substances in heterogeneous mixtures are usually easy to tell apart. A bowl of cereal with milk is another example of a heterogeneous mixture.

What are homogeneous mixtures?

When you mix sugar and water together you don't see the sugar particles floating in the water. Sugar water is a homogeneous (ho muh JEE nee us) mixture. A **homogeneous mixture** has two or more substances in which the molecules mix evenly but do not bond together. Another name for a homogeneous mixture is a **solution.** The figure shows the mixture of sugar and water molecules in a solution of sugar water.



How Solutions Form

When you mix sugar and water together, you can't see the sugar particles in the water. The sugar doesn't actually disappear. The sugar molecules spread out until they are evenly spaced throughout the water molecules, forming a solution. This is called dissolving. The substance in a solution that dissolves, or seems to disappear, is called the **solute.** The substance that dissolves the solute in a solution is the **solvent.** In the sugar water solution, the sugar is the solute and water is the solvent.

How can solids form from solutions?

Sometimes, a solute can come back out of a solution and form a solid. This process is called crystallization.

Crystallization Crystallization happens because of a physical change. For example, crystallization can happen when a solution is cooled. Crystallization also can happen when some of the solvent evaporates. A stalactite, or hanging rock, in a cave is an example of crystallization. Minerals dissolve in water as it flows through rocks. When the solution drips from the ceiling of the cave, some of the water evaporates. The minerals in the solution crystallize to form the stalactite.

Picture This

3. Describe Look at the figure. How would you describe the sugar and water molecules in a solution of sugar water? Circle the answer.

a. not mixed evenly
b. combined
c. mixed evenly
d. compounded

Think it Over

4. Apply Minerals dissolve in water as it flows through rocks at the top of the cave. In this solution, what is the solute and what is the solvent?

Precipitate Formation When some solutions are mixed, a chemical change happens and a solid forms. A solid that forms when solutions are mixed and a chemical change happens is a **precipitate** (prih SIH puh tut). Precipitate formation is different from crystallization because a chemical change takes place. A precipitate can form in a shower. Minerals that are dissolved in water can react chemically with soap. This chemical reaction forms a precipitate called soap scum.

Types of Solutions

Not all solutions are solid solutes dissolved in liquid solvents. Solutions can be made up of combinations of solids, liquids, and gases. See the examples in the table.

Picture This

5. Interpret Data Name two solutions that have carbon dioxide as one of the solutes.

_____

_____

_____

Examples of Common Solutions

Solution	Solvent/ State	Solute/ State	State of Solution
Earth's atmosphere	nitrogen/gas	oxygen/gas carbon dioxide/gas argon/gas	gas
Carbonated beverage	water/liquid	carbon dioxide/gas	liquid
Brass	copper/solid	zinc/solid	solid

Liquid Solutions

Sugar water and salt water are examples of solutions with liquid solvents and solid solutes. The solute in a solution can be a solid, another liquid, or even a gas. The state of the solution will usually be the same as the state of the solvent. For example, sugar is a solid and water is a liquid. When sugar and water are mixed together to form a solution, the solution is a liquid, not a solid.

Reading Check

6. Explain What does the state of a solution usually depend on?

_____

_____

What are liquid-gas and liquid-liquid solutions?

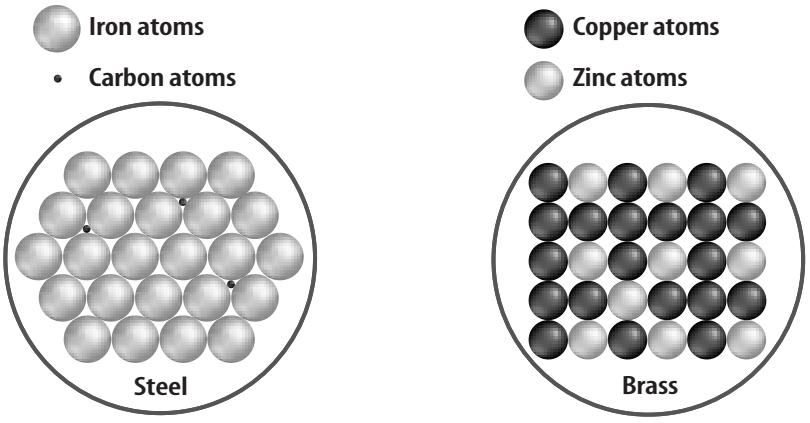
Liquid-Gas Carbonated drinks are examples of solutions with liquid solvents and gas solutes. The gas solute is carbon dioxide. Water is the liquid solvent. Carbon dioxide gives the drinks their fizz.

Liquid-Liquid Vinegar is an example of a liquid-liquid solution. Water is the liquid solvent and acetic acid is the liquid solute. In vinegar, only 5 percent of the solution is acetic acid. Water makes up 95 percent of the solution.

Gaseous and Solid Solutions

Gas Solutions Sometimes, a small amount of one gas is dissolved in a larger amount of another gas. This is a gaseous solution, also called a gas-gas solution. The air you breathe is a gaseous solution. About 78 percent of air is nitrogen, which is the solvent. About 20 percent of air is oxygen, which is one of the solutes. Other solutes in air are carbon dioxide, argon, and some other gases in small amounts.

Solid Solutions There are also solid solutions. In a solid solution, the solvent is solid. The solute can be a solid, liquid, or gas. The most common solid solutions are solid-solid solutions. Both the solvent and solute are solids. Steel is a solution of carbon dissolved in iron. A solid-solid solution made from two or more metals is called an alloy. Brass is an alloy of zinc dissolved in copper. The figure shows what microscopic views of steel and brass might look like.



Reading Check

7. **Identify** What states can the solutes be in a solid solution?

Applying Math

8. **Interpret a Scientific Illustration** Look at the sample of brass in the figure. What is the ratio of copper atoms to the total number of atoms?

After You Read

Mini Glossary

heterogeneous mixture: a mixture where the substances are not mixed evenly

homogeneous mixture: a mixture that has two or more substances in which the molecules mix evenly, but do not bond together

precipitate: a solid that forms when solutions are mixed and a chemical change happens

solute: the substance in a solution that dissolves, or seems to disappear

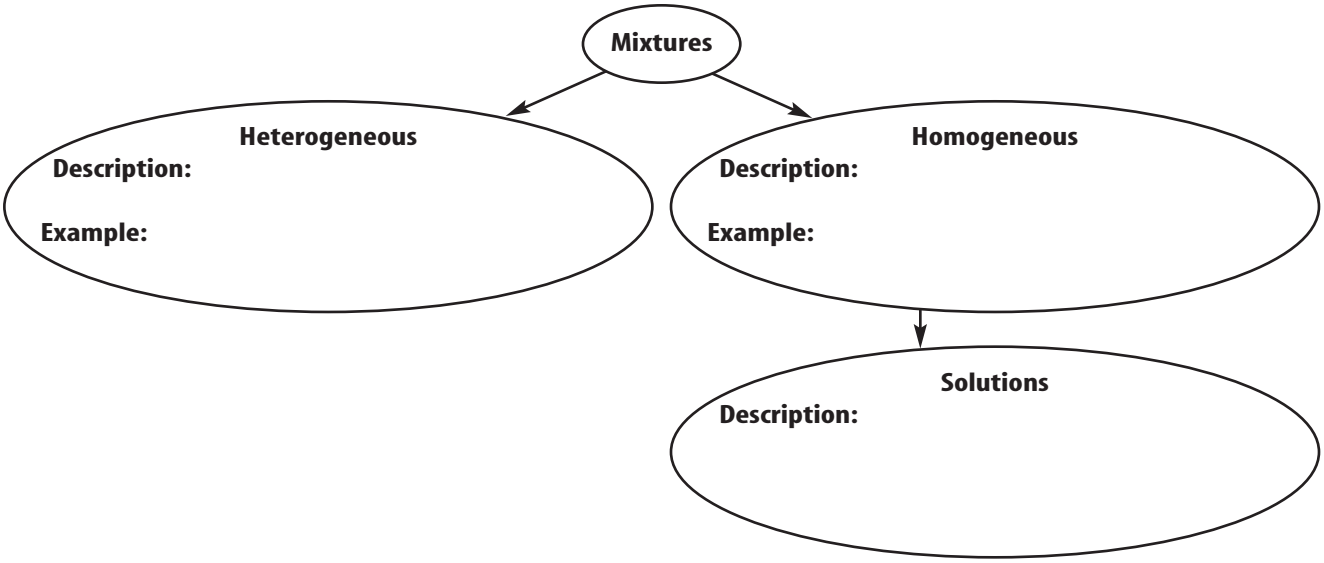
solution: another name for a homogeneous mixture

solvent: the substance that dissolves the solute in a solution

substance: matter that has the same fixed makeup and properties throughout

1. Review the terms and their definitions in the Mini Glossary. Write a sentence using at least one glossary term to describe the mixture of vegetables in a salad.

2. Fill in the graphic organizer with important facts about mixtures and solutions



3. As you read this section, you underlined words and sentences that you thought were important. How did you decide what to underline?

End of Section

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chapter 8

Substances, Mixtures, and Solubility

section 2 Solubility

Before You Read

What happens when you put one teaspoon of sugar in a glass of water? What would happen if you put one cup of sugar in a glass of water?

_____

_____

What You'll Learn

- why water is a good solvent
- how much of a solute will dissolve in a solvent
- how temperature affects chemical reactions

Read to Learn

Water—The Universal Solvent

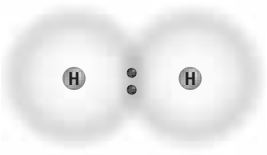
Water is a solvent for many solutions, including fruit juice and vinegar. A solution in which water is the solvent is called an **aqueous** (A kwee us) solution. Water dissolves things so well it is often called the universal solvent.

What are molecular compounds?

You know that atoms can join with other atoms to form compounds. When certain atoms form compounds, they share electrons. Sharing electrons is called covalent (co VAY lent) bonding. Compounds that have covalent bonds are called molecular compounds, or molecules.

Nonpolar Molecules In some molecules, the atoms share their electrons equally. When the electrons are shared evenly, the molecule is called nonpolar. Look at the hydrogen molecule. A hydrogen molecule is nonpolar.

Hydrogen Molecule

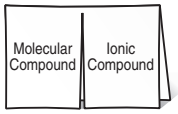


Study Coach

Make Flash Cards As you read, write important questions on note cards. Write the answer to each question on the back of the card. After you read, see if you can answer your questions without looking at the answers.

FOLDABLES™

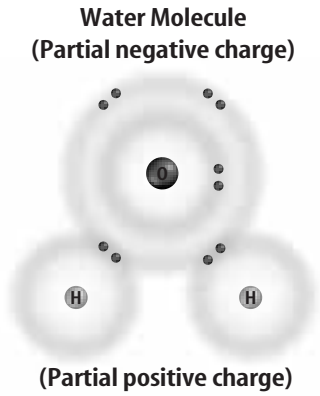
B Compare and Contrast Make the following Foldable to show how molecular compounds and ionic compounds are alike and different.



Picture This

1. **Circle** the shared electrons in the figure.

Polar Molecules The atoms in some molecules do not share their electrons equally. Look at the water molecule. Two hydrogen atoms share electrons with one oxygen atom. But, the electrons spend more time around the oxygen atom than they spend around the hydrogen atom. This makes the oxygen part of the water molecule have a slightly negative charge. The hydrogen parts have a slightly positive charge. The total charge of the water molecule is neutral. Molecules that have slightly positive and slightly negative charges are called polar molecules. The bonds between its atoms are called polar covalent bonds.



What are ionic bonds?

Some atoms do not share electrons when they join to form compounds. Instead, these atoms lose or gain electrons making the number of protons and electrons in the atom no longer equal. The atom becomes either positively charged or negatively charged. Atoms with a charge are called ions. Bonds between ions are called ionic bonds. The compound that is formed is called an ionic compound. Table salt is an ionic compound. It is made of sodium ions and chloride ions. Each sodium atom loses an electron to a chlorine atom and becomes positively charged. The chlorine atoms gain the electrons from the sodium atoms and become negatively charged.

Reading Check

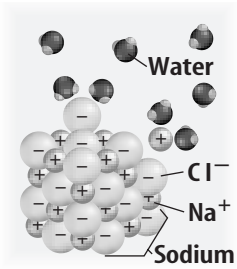
2. **Summarize** Write the correct words to complete the sentence on the lines below: Atoms in an ionic compound ____a.____ or ____b.____ electrons.

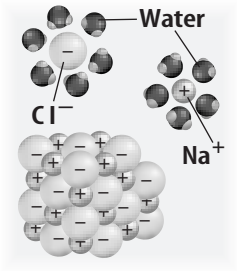
a. _____

b. _____

How does water dissolve ionic compounds?

Remember that a water molecule is polar. It attracts positive and negative ions. Look at the figure. When sodium chloride, or table salt, is added to water, the sodium (Na) ions and chloride (Cl) ions are attracted by the water molecules. The slightly negative end of a water molecule attracts positive sodium ions (Na^+). The slightly positive end of a water molecule attracts negative chloride ions (Cl^-). When an ionic compound is mixed with water, the ions are pulled apart, or dissolved, by the water molecules.





Picture This

3. **Highlight** Use a highlighter to circle the part of the figure that shows the dissolved table salt.

How does water dissolve molecular compounds?

Water does dissolve molecular compounds, like sugar, that are not made of ions. But, water does not break sugar molecules apart as it does in ionic compounds. Sugar molecules are polar, like water molecules. Polar water molecules are attracted to the positive and negative ends of the sugar molecules. The water molecules move in between sugar molecules and spread them apart. When this happens, the sugar dissolves.

What will dissolve?

When you put a teaspoon of sugar in iced tea and stir it, what happens? The sugar dissolves. Why doesn't the spoon dissolve? A substance that dissolves in another substance is soluble, or able to be dissolved in that substance. Sugar is soluble in water. You would say the metal of the spoon is insoluble in water because it does not dissolve.

What does "like dissolves like" mean?

Chemists use the phrase "like dissolves like" to remember which solvents can dissolve which solutes. "Like dissolves like" means polar solvents dissolve polar solutes. Also, nonpolar solvents dissolve nonpolar solutes. Sugar and water are both polar, so water dissolves sugar. Why does water dissolve sodium chloride? Remember, the sodium and chloride ions have charges like polar molecules. So, water reacts with these ions in the same way it reacts with other polar molecules.

Have you ever mixed oil and water in a glass? They do not form a solution. Instead, the two liquids separate and form layers in the glass. Oil molecules are nonpolar. Polar water molecules are not attracted to them. So, oil will not dissolve in water.

How much will dissolve?

Solubility (sahl yuh BIH luh tee) is the measurement that describes how much solute dissolves in a given amount of solvent. Usually, solubility is the amount of solute that can dissolve in 100 g of solvent at a certain temperature. Some solutes are highly soluble. This means that a large amount of solute can be dissolved in 100 g of solvent. For example, 63 g of potassium chromate will dissolve in 100 g of water at 25°C. But, some solutes are not very soluble. Only 0.00025 g of barium sulfate will dissolve in 100 g of water at 25°C. This solubility is so low that it is called insoluble.

Reading Check

4. **Recall** What does "like dissolves like" mean?

_____

_____

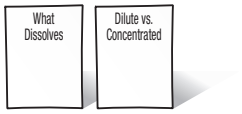
_____

_____

FOLDABLES™

Organize Information

Use two quarter-sheets of paper to write information about solutions and how they dissolve.



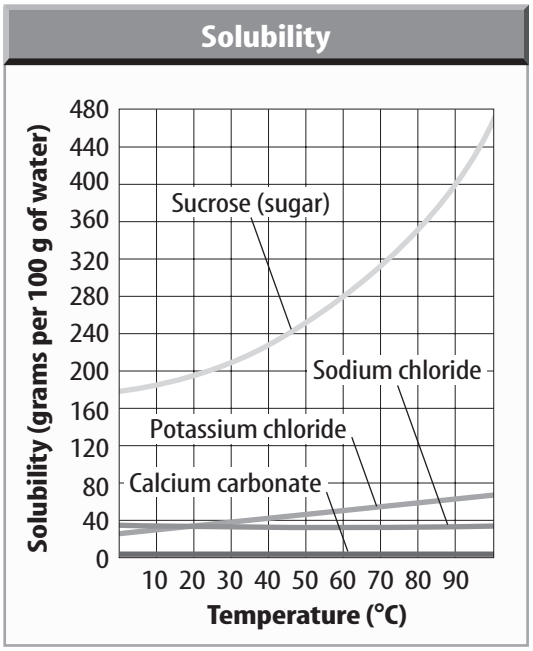
How does temperature affect solubility?

The solubility of many solutes changes with the temperature of the solvent. Sugar dissolves faster in hot tea than it does in iced tea. Also, more sugar can dissolve in hot tea than in iced tea. The solubility and the rate that sugar dissolves in water increases as temperature increases.

This is not true of all solutes. The graph shows the solubility at different temperatures of several solutes in water. An increase in temperature decreases the solubility of a gas in a liquid-gas solution. That is why cold sodas fizz less than warm sodas when you open them.

Applying Math

5. **Interpret Data** How many grams of sugar will dissolve in 100 g of water at 60°C?



What are saturated solutions?

If you add potassium chromate to 100 g of water at 25°C, only 63 g of it will dissolve. A solution that contains all of the solute that it can hold under the given conditions is **saturated.** When a solution has less solute than what is needed to become saturated, it is called an unsaturated solution. Look at the graph above. A saturated sugar water solution would contain about 204 g of sugar in 100 g of water at 25°C. If less sugar is used, the solution is unsaturated.

A hot solvent usually can hold more solute that a cold solvent. When a saturated solution cools, some of the solute usually falls out of solution. But, if a saturated solution is cooled slowly, sometimes the extra solute can stay dissolved. This is called a supersaturated solution.

Think it Over

6. **Apply** Tell whether this solution is saturated or unsaturated: 50 g of sugar in 100 g of water at 25°C.

Rate of Dissolving

A solute dissolves faster when the solution is shaken or stirred or heated. These actions make the surfaces of the solute come into contact with the solvent more quickly. You can do the same thing by breaking up or grinding the solute into smaller pieces. For example, granules of sugar dissolve more quickly than sugar cubes. Grinding increases the surface area of the solute that is exposed to the solvent.

Chemical reactions happen when molecules bump into each other. At colder temperatures, chemical reactions happen more slowly. Refrigerators slow the chemical reactions that cause food to spoil. So, food stays fresh longer in a refrigerator than at room temperature.

Concentration

The **concentration** of a solution tells you how much solute is in a solution compared to the amount of solvent. A concentrated solution has a lot of solute for a given amount of solvent. A dilute solution has little solute for a given amount of solvent.

How do you measure concentration?

Doctors need to give the exact concentration of medicines so patients will be treated correctly. One way to give an exact concentration is to give the percentage of the volume of the solution that is made of solute. The label of a fruit juice container might say, "contains 10 percent juice." This means that 10 percent of the container is the solute: juice. Ninety percent is the solvent: water and other substances like sugar.

How do solute particles affect solvents?

Solutes often change the freezing and boiling points of solvents. When liquids freeze, their molecules arrange themselves in certain ways. Solute particles can change the way the molecules arrange themselves and lower the freezing point.

When liquids boil, their molecules gain enough energy to move from the liquid state to the gaseous state. Solute particles can interfere with the change from liquid to gaseous state. More energy is needed to make the solvent particles escape from the liquid. This increases the boiling point.

Think it Over

7. Infer A metal worker needs an acid to dissolve metal. Does she probably need an acid that is concentrated or dilute?

_____

Reading Check

8. Determine What do solutes often change in solvents?

_____

_____

After You Read

Mini Glossary

aqueous: a solution in which water is the solvent

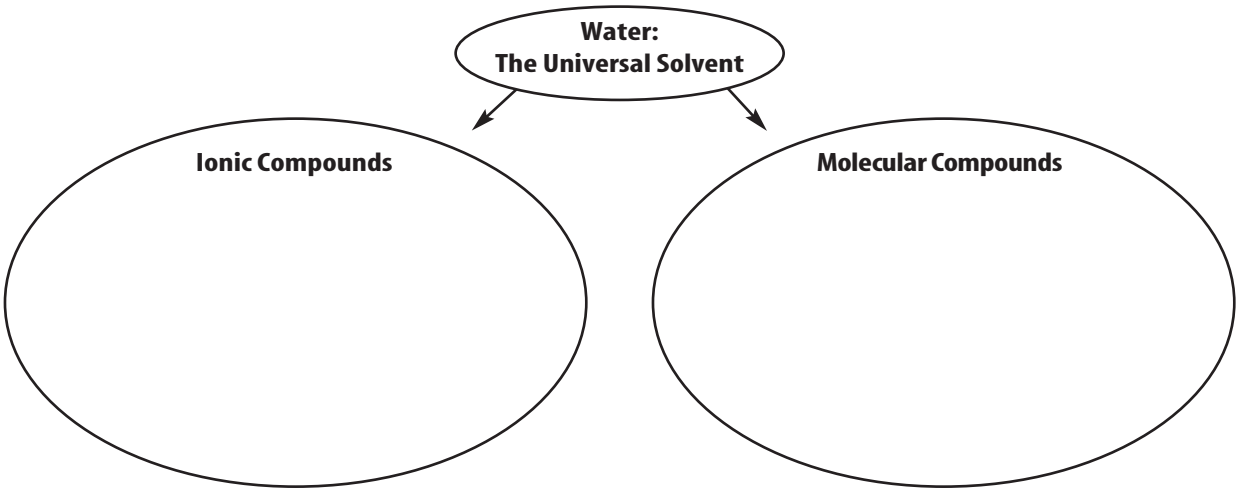
concentration: how much solute is in a solution compared to the amount of solvent

saturated: a solution that contains of all the solute that it can hold under given conditions

solubility: the measurement that describes how much solute dissolves in a given amount of solvent

1. Review the terms and their definitions in the Mini Glossary. Use two of the terms in one or two sentences to describe a bottle of orange juice.

2. In the graphic organizer, explain how water dissolves the types of compounds shown.



3. How could you use lemonade to teach others about the concentrations of solutions?

End of Section

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chapter 8

Substances, Mixtures, and Solubility

section 3 Acidic and Basic Solutions

What You'll Learn

- about acids, bases, and their properties
- uses of acids and bases
- pH of acids and bases

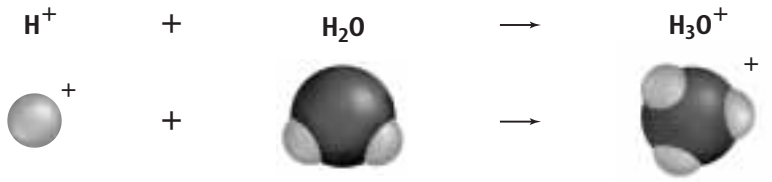
Before You Read

Name some sour foods that you like.

Read to Learn

Acids

If you like sour foods like dill pickles and lemons, you like foods that have acids. An **acid** is a substance that releases positively charged hydrogen ions ($H+$) in water. When an acid mixes with water, it dissolves, releasing hydrogen ions. The hydrogen ions then join with water molecules to form hydronium ions. A **hydronium ion** is a positively charged ion that has the formula H_3O^+. The figure shows how a hydronium ion is made.



Hydrogen ion | Water molecule | Hydronium ion

What are the properties of acidic solutions?

Sour taste is one property of acidic solutions. Remember, you should never taste substances in the laboratory. Many acids can cause severe burns to body tissues. Acidic solutions also can conduct electricity. Hydronium ions are good carriers of electric charges in an electric current. This is why some batteries contain acids.

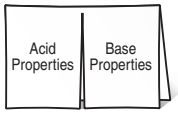
Study Coach

Outline Make an outline of this section as you read. When you finish reading, look over your outline to make sure you understand what you have written down.

FOLDABLES™

D Compare and Contrast

Make the following Foldable to show how acids and bases are alike and different.



Many acids are corrosive. This means they can break down certain substances. Many acids can corrode fabric, skin, and paper. Some acids react strongly with metals. When these acids are put on metal, metal compounds and hydrogen gas form, leaving holes in the metal.

What are some uses of acids?

Vinegar contains acetic acid. It is used in salad dressings. Citrus fruits like lemons, limes, and oranges taste sour because they contain citric acid. Your body needs vitamin C, which is ascorbic acid. Ants that sting inject formic acid into their victims. The figure shows products that are made with acids.

Picture This

1. **List** the products in the figure that you have seen or used.

John Evans

Sulfuric acid is used to make fertilizers, steel, paints, and plastics. It is also called battery acid because it is used in many batteries, such as car batteries. Hydrochloric acid is also called muriatic acid. It is used to remove impurities from the surfaces of metals. Hydrochloric acid also can be used to clean mortar from brick walls. Nitric acid is used to make fertilizers, dyes, and plastics.

Where are acids found in nature?

Caves form because of acids. Carbonic acid is made when carbon dioxide from soil dissolves in water. The carbonic acid solution dissolves limestone rock in the ground. Over many years, enough limestone dissolves to form a cave. Stalactites and stalagmites, hanging rocks and columns in caves, are also made when a carbonic acid solution drips from the ceiling of a cave. As the water evaporates, the solution becomes less acidic and the limestone comes out of solution.

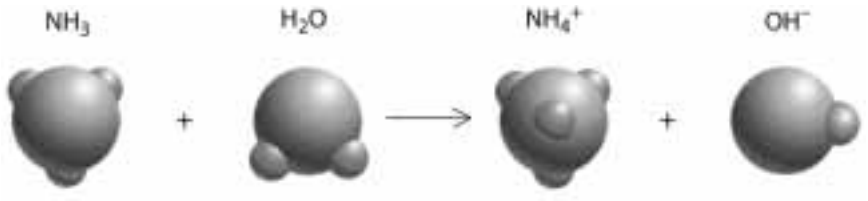
When fossil fuels burn, many compounds are released into the air. Some of these compounds form nitric acid and sulfuric acid. These strong acids mix with water vapor and fall back to Earth as rain, sleet, snow, or fog. The acid rain can corrode stone statues, damage forests, and make people sick.

Reading Check

2. **Name** three acids found in nature.

Bases

Many window and floor cleaners contain an ammonia solution. Ammonia contains a base. A **base** is a substance that can accept hydrogen ions. When bases dissolve in water, they release a hydroxide ion (OH^-). For example, when sodium hydroxide (NaOH) dissolves in water, it separates into sodium ions (Na^+) and hydroxide ions (OH^-). Ammonia (NH_3) is different. When it dissolves in water, it pulls a hydrogen atom away from water. This leaves a hydroxide ion. Look at the figure below.



What are the properties and uses of bases?

Properties Most soaps are bases. How does soap feel? Basic solutions, like soap, feel slippery. Bases are corrosive like acids. They can cause burns and damage body tissue. That's why you should never touch, smell, or taste a substance to find out if it is a base or an acid. Bases can conduct electricity like acids. They are not as corrosive to metals as acids.

Uses Many uses for bases are shown in the figure below. Bases are used in plastics, soap, ammonia, and other cleaning products. Hydroxide ions can react with dirt and grease to wash them away. Calcium hydroxide, often called lime, is used to mark lines on athletic fields. It also can make soil less acidic. Sodium hydroxide is a base called lye. Lye is a strong base that can cause burns and other health problems. It is used to make soap, clean ovens, and unclog drains.

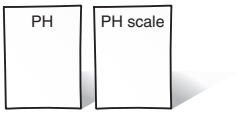
John Evans

Picture This

3. **Draw and Label** Circle the hydroxide ion in this reaction.

FOLDABLES™

E Organize Information
Use quarter-sheets of paper to help you organize and list information about pH.



Picture This

4. **Circle** the base in the figure that is used in classrooms every day.

What is pH?

pH is a way to measure how acidic or basic a solution is. Perhaps you've seen someone check the pH of a swimming pool. The pH scale ranges from 0 to 14. Acids have a pH below 7. Bases have a pH above 7. Solutions with a pH of 7 are called neutral. They are neither acids nor bases. Strong acids, like hydrochloric acid, have a pH of 0. Strong bases have a pH of 14.

The pH of a solution depends on its concentration of hydronium ions (H_3O^+) and hydroxide ions (OH^-). Acids have more hydronium ions than hydroxide ions. Neutral solutions have equal numbers of each ion. Basic solutions have more hydroxide ions than hydronium ions.

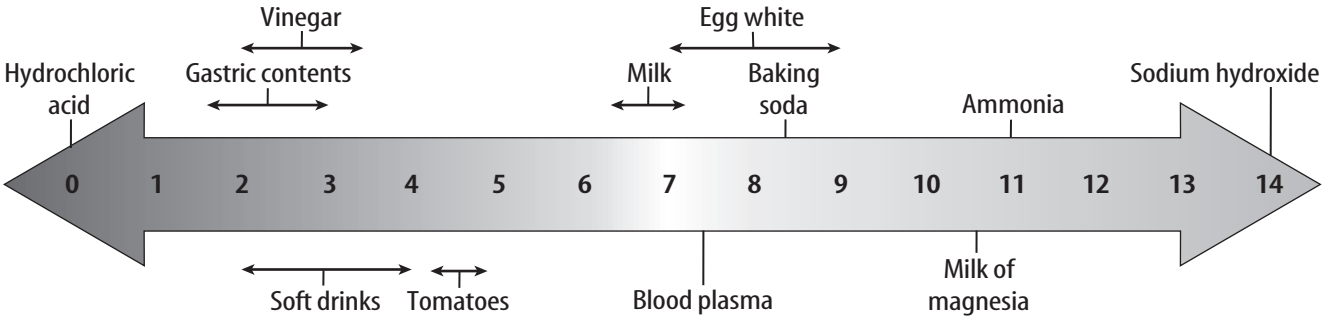
Applying Math

5. Calculate Look at the pH scale. How many times more acidic is an acid with a pH of 2 than an acid with a pH of 5?

_____

How does the pH scale work?

Each pH unit is a change in acidity that is multiple of 10. The lower the number, the more acidic a solution is. An acid with a pH of 2 is 10 times stronger than an acid with a pH of 3 and 100 times stronger than an acid with a pH of 4. A base with a pH of 13 is 10 times stronger than a base with a pH of 12 and 100 times stronger than a base with a pH of 11.



Picture This

6. Label In the figure above, write the labels "Acids," "Bases," and "Neutral" at the correct places.

What makes a strong acid or a strong base?

Some acids give foods a sour taste, and some other acids are so strong that they can cause burns. Vinegar, or acetic acid, makes pickles sour, but you can eat pickles because the acid is weak. Hydrochloric acid, a strong acid, would dangerously burn your mouth. What makes these acids different? The ions of strong acids break apart in water more easily than the ions of weak acids. Strong acids form many more hydronium ions than weak acids. More hydronium ions give a lower pH, which is more acidic. Strong bases form many more hydroxide ions than weak bases. More hydroxide ions give a higher pH, which is more basic.

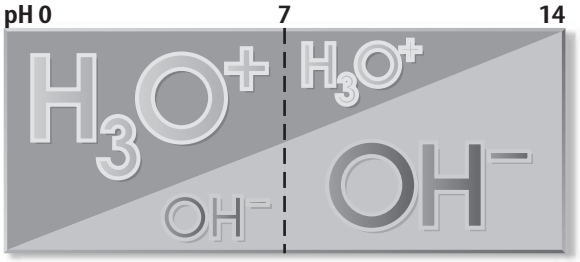
Indicators

Is there a safe way to find out how acidic or basic a solution is? Yes, you can use an indicator. An **indicator** is a compound that turns a certain color in acidic or basic solutions, depending on the pH. An example of an indicator is litmus. This compound is soaked into paper strips. You place the paper strips in a solution and look at the color. Litmus paper turns red in acids and blue in bases.

Neutralization

Have you ever heard of heartburn? Someone with heartburn might take an antacid tablet. The prefix *ant-* means "opposite of." Heartburn is caused by having too much hydrochloric acid in the stomach. An antacid tablet neutralizes the extra acid. How does an antacid tablet work?

An antacid is made from a base that neutralizes the extra acid in the stomach. **Neutralization** (new truh luh ZAY shun) is the reaction of an acid with a base. It is called this because properties of both the acid and the base are reduced, or neutralized. When a base and acid are mixed, they usually form water and a salt. Because of the reaction, there are fewer hydronium and hydroxide ions in the solution. This makes the pH of the solution more neutral. So, when a base such as magnesium hydroxide, $Mg(OH)_2$, in an antacid reacts with hydrochloric acid in the stomach, some of the acid is neutralized. The figure shows the relative amounts of hydronium and hydroxide ions between pH 0 and pH 14.



How does neutralization occur?

When a solution is neutralized, hydronium and hydroxide ions react with each other. During neutralization, equal numbers of hydronium ions and hydroxide ions react to produce water molecules. Pure water has a pH of 7, which means it is neutral.

Think it Over

7. Apply To neutralize a solution that contains lye, what would be added?

_____

Picture This

8. Compare At pH 7, how does the amount of hydronium ions compare to the amount of hydroxide ions?

_____

_____

After You Read

Mini Glossary

acid: a substance that releases positively charged hydrogen ions (H^+) in water

base: a substance that can accept hydrogen ions

hydronium ion: a positively charged ion that has the formula H_3O^+

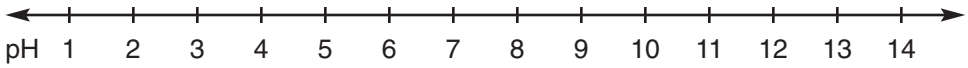
indicator: a compound that turns a certain color in acidic or basic solutions, depending on the pH

neutralization: reaction of an acid with a base

pH: a measure of how acidic or basic a solution is

1. Review the terms and their definitions in the Mini Glossary. Write one or two sentences to explain the pH of pure water.

2. Label the location of pure water on the pH scale. Label the acidic side of the scale in red and the basic side in blue.



3. How much stronger is a pH of 9 than a pH of 4?

4. Suppose you add water to solutions to make acids of different strengths. You add 100 mL of water to an acid to make an acid with pH of 6. How much water would you add to make an acid with pH of 5? Explain.

End of Section

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