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Chapter Preview Questions

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   b. heterogeneous colloid.
   c. homogeneous mixture.
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Chapter Preview Questions

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Chapter Preview Questions

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   a. ionic compounds.
   b. molecular compounds.
   c. covalent electrons.
   d. radioactive elements.

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   a. conduct electricity.
   b. make the water cloudy.
   c. form double and triple bonds.
   d. do not conduct electricity.

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Chapter Preview Questions

4. When dissolved in water, molecular compounds
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   c. form double and triple bonds.
   d. do not conduct electricity.

Chapter Preview Questions

4. When dissolved in water, molecular compounds

a. conduct electricity.

b. make the water cloudy.

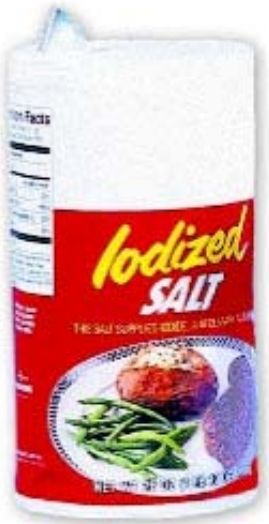
c. form double and triple bonds.

d. do not conduct electricity.

Focus on the BIG Idea

What are some characteristics of acids and bases?

Suppose you dissolve a teaspoon of salt in a glass of water. Is it possible to recover the salt from the water? Explain.



Build Science Vocabulary

Use Related Words

Verb	Noun	Adjective
indicate To show; to point to	**indicator** Something that shows or points to	**indicative** Serving as a sign; showing

Build Science Vocabulary

Use Related Words

Verb	Noun	Adjective
saturate To fill up as much as is possible	**saturation** The condition of holding as much as is possible	**saturated** To be full; to hold as much as is possible

Build Science Vocabulary

Use Related Words

Verb	Noun	Adjective
suspend To hang so as to allow free movement	**suspension** The condition of hanging or moving freely	**suspended** Hanging so as to allow free movement

Build Science Vocabulary

Apply It!

Review the words related to saturate. Complete the following sentences with the correct form of the word.

1. The _____ sponge could hold no more water.

saturated

2. He continued to add water to the point of _____.

saturation

End of Chapter Preview

Section 1: Understanding Solutions

- What are the characteristics of solutions, colloids, and suspensions?
- What happens to the particles of a solute when a solution forms?
- How do solutes affect the freezing point and boiling point of a solvent?

What Is a Solution?

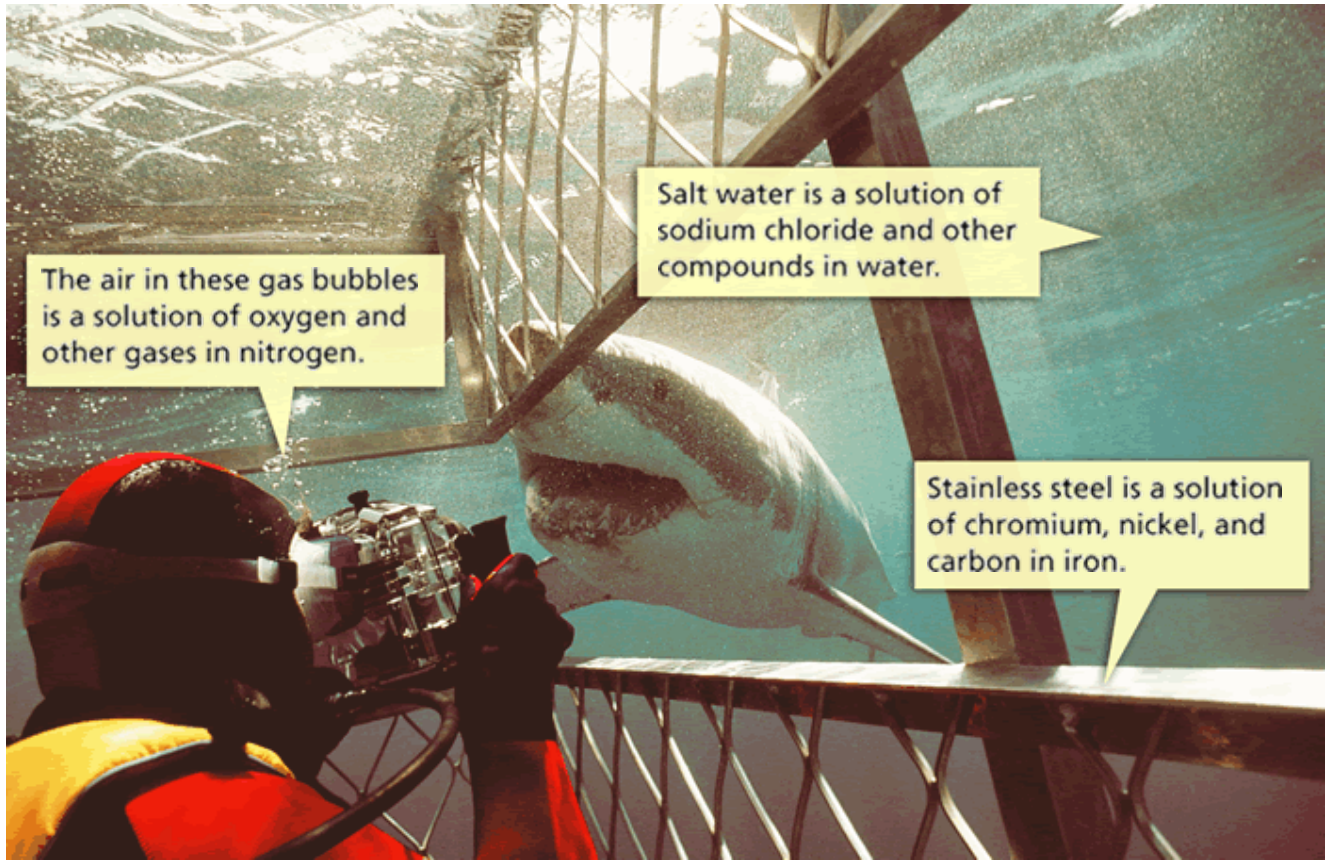
A solution has the same properties throughout. It contains solute particles (molecules or ions) that are too small to see.

Examples of Common Solutions

Solute	Solvent	Solution
Gas	Gas	Air (oxygen and other gases in nitrogen)
Gas	Liquid	Soda water (carbon dioxide in water)
Liquid	Liquid	Antifreeze (ethylene glycol in water)
Solid	Liquid	Dental filling (silver in mercury)
Solid	Liquid	Ocean water (sodium chloride and other compounds in water)
Solid	Solid	Stainless steel (chromium, nickel, and carbon in iron)

What Is a Solution?

Solutions can be formed from any combination of solids, liquids, and gases.



Colloids and Suspensions

Colloids and suspensions are mixtures that have different properties than solutions.

Solution
In a solution of glass cleaner, particles are uniformly distributed and too small to scatter light.

Colloid
Fats and proteins in milk form globular particles that are big enough to scatter light, but are too small to be seen.

Suspension
Suspended particles of "snow" in water are easy to see.

Particles in a Solution

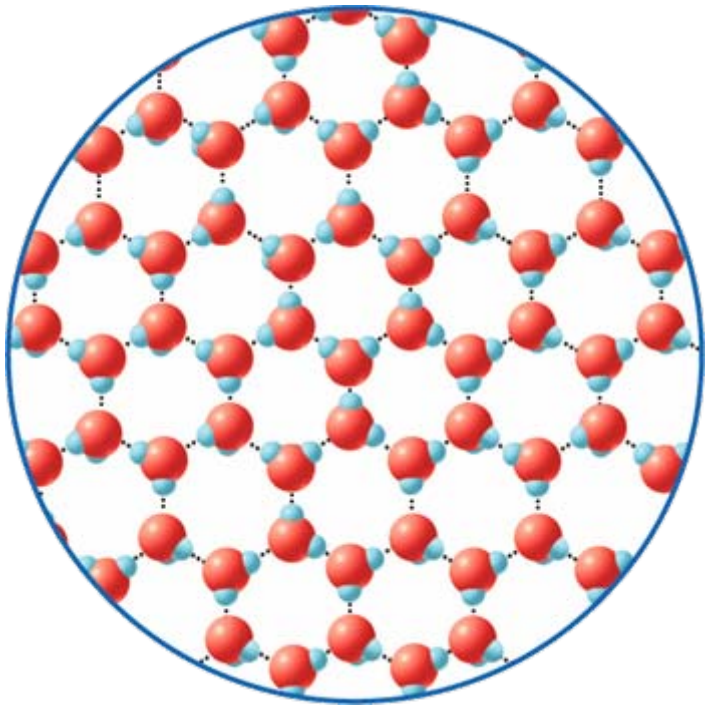
When a solution forms, particles of the solvent surround and separate the particles of the solute.

Salt Dissolving in Water Activity

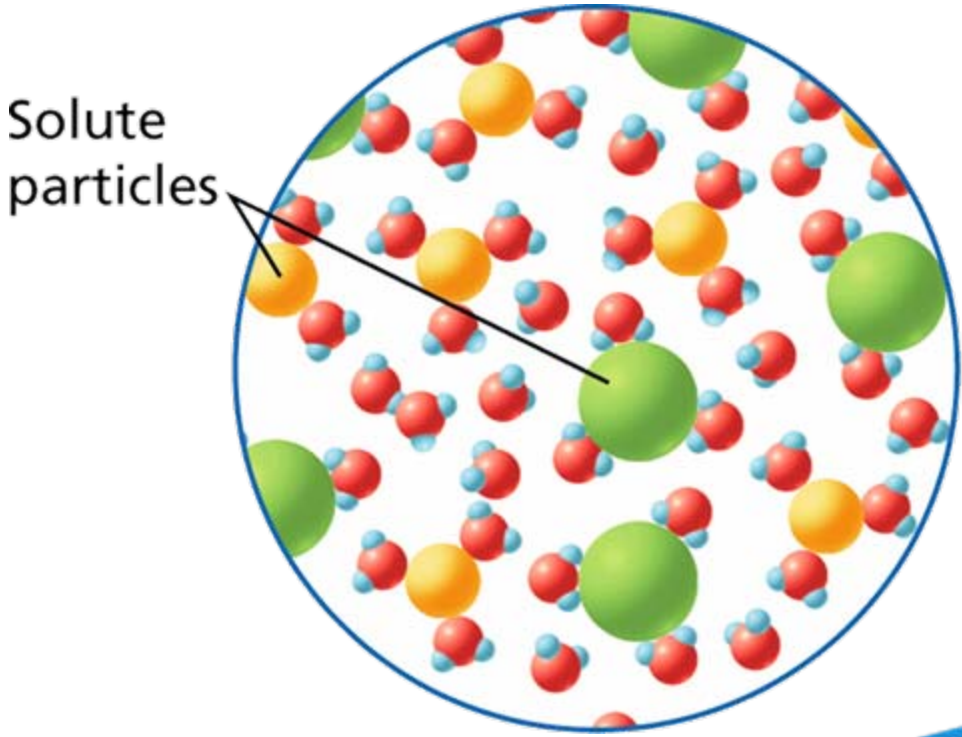
Click the Active Art button to open a browser window and access Active Art about salt dissolving in water.

Effects of Solutes on Solvents

Solutes lower the freezing point and raise the boiling point of a solvent.



Solid (frozen) water



Liquid water solution

Universal Solvent

Click the Video button to watch a movie about universal solvent.

End of Section: Understanding Solutions

Section 2: Concentration and Solubility

- How is concentration measured?
- Why is solubility useful in identifying substances?
- What factors affect the solubility of a substance?

Math Skills

Calculating a Concentration

To calculate the concentration of a solution, compare the amount of solute to the amount of solution and multiply by 100 percent.

For example, if a solution contains 10 grams of solute dissolved in 100 grams of solution, then its concentration can be reported as 10 percent.

$$\frac{10\ \text{g}}{100\ \text{g}} \times 100\% = 10\%$$

Math Skills

Calculating a Concentration

Practice Problem

Q. A solution contains 12 grams of solute dissolved in 36 grams of solution. What is the concentration of the solution?

A. 33%

Solubility

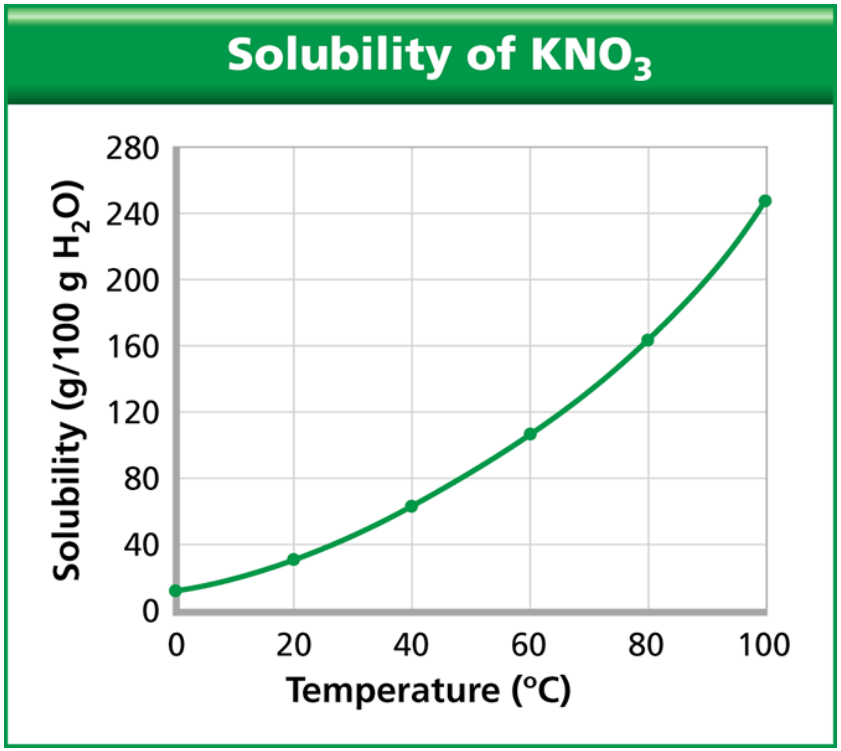
Solubility in 100 g of Water at 0°C	
Compound	**Solubility (g)**
*Carbon dioxide (CO_2)	0.335
Baking soda ($NaHCO_3$)	6.9
Table salt (NaCl)	35.7
Table sugar ($C_{12}H_{22}O_{11}$)	180

*CO_2 at 101 kPa total pressure

Solubility is a measure of how much solute can dissolve in a solvent at a given temperature.

Math Analyzing Data

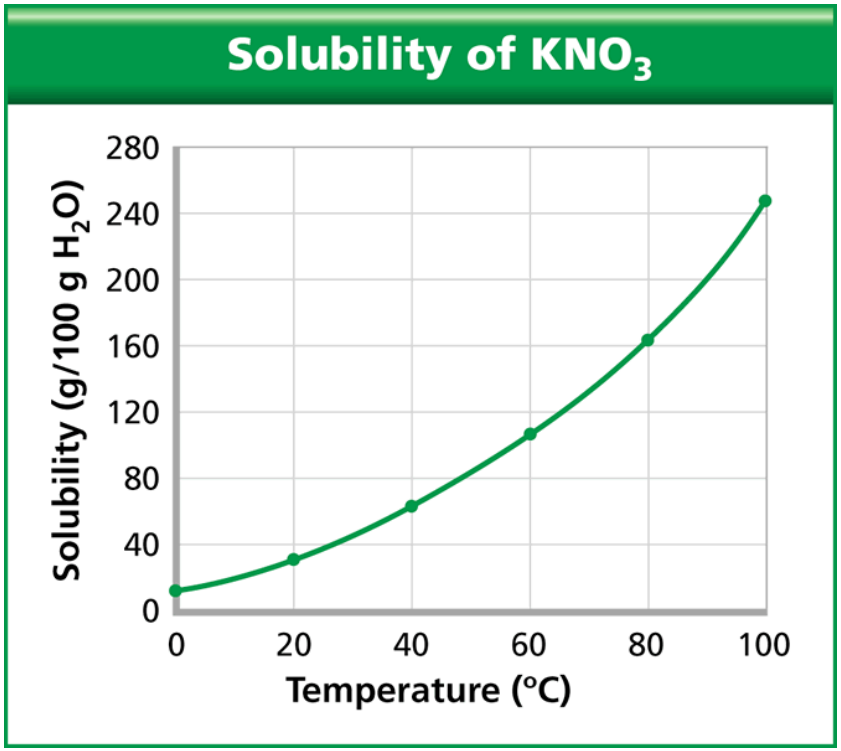
Temperature and Solubility



The solubility of the compound potassium nitrate (KNO_3) varies in water at different temperatures.

Math Analyzing Data

Temperature and Solubility



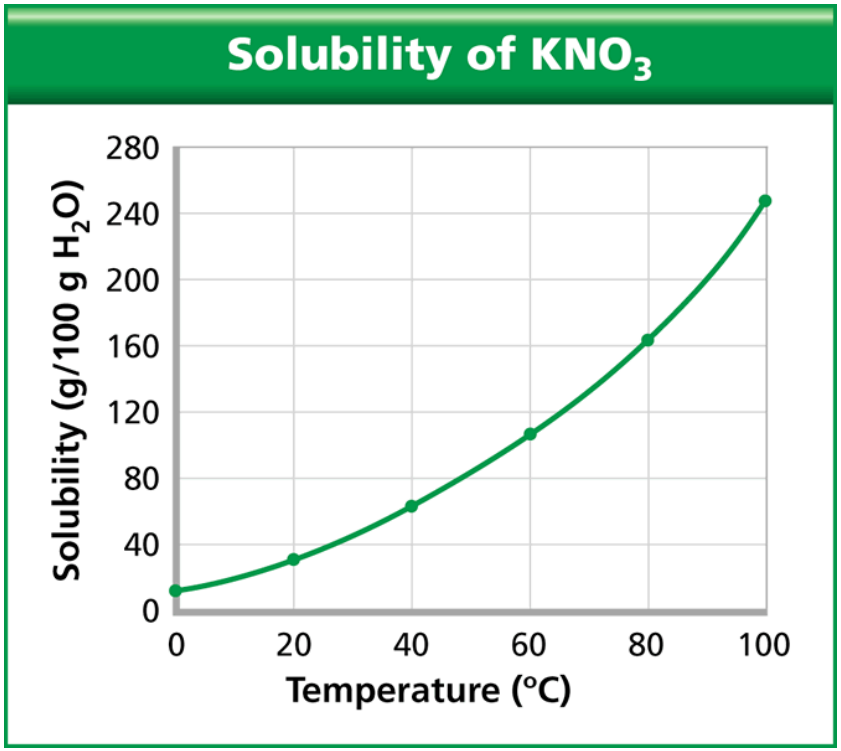
Reading Graphs:

Q. At which temperature shown in the graph is KNO_3 least soluble in water?

A. KNO_3 is least soluble at 0°C.

Math Analyzing Data

Temperature and Solubility



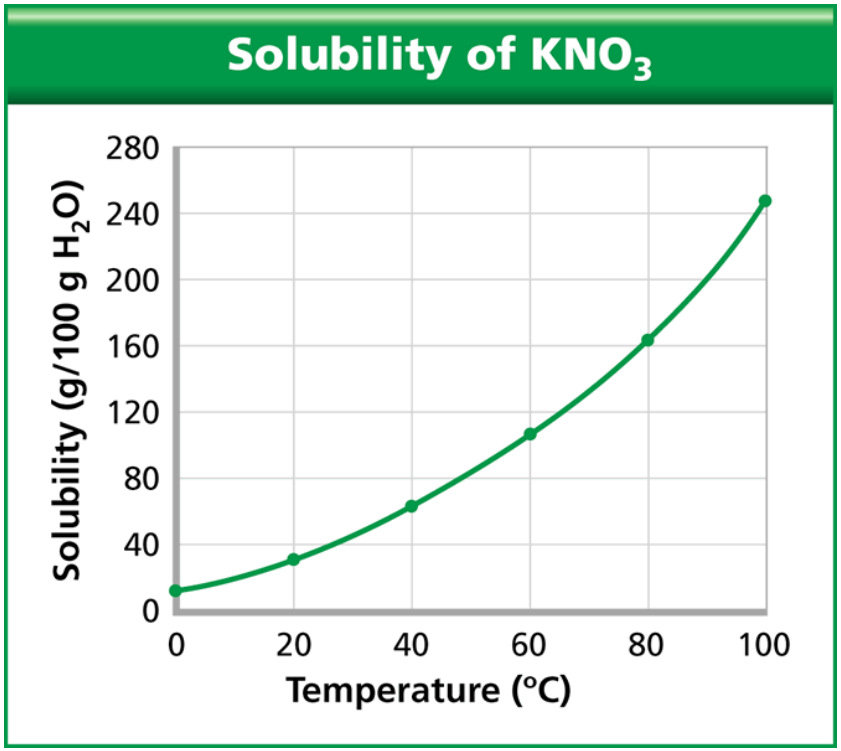
Reading Graphs:

Q. Approximately what mass of KNO_3 is needed to saturate a water solution at 40°C?

A. Approximately 65 g of KNO_3 are needed to saturate a water solution at 40°C.

Math Analyzing Data

Temperature and Solubility



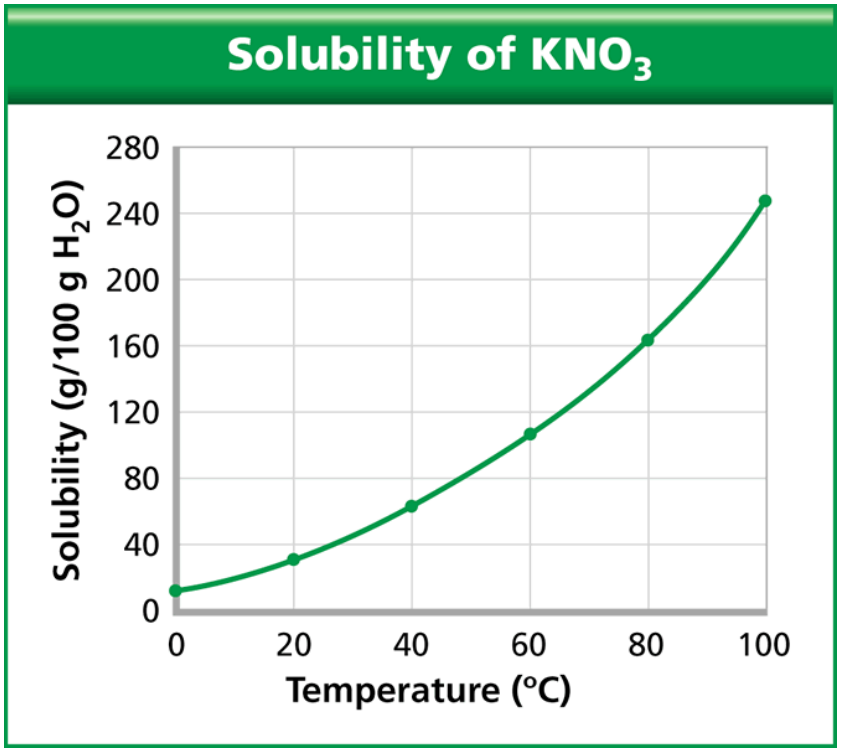
Calculating:

Q. About how much more soluble is KNO_3 at 40°C than at 20°C?

A. KNO_3 is about twice as soluble at 40°C as it is at 20°C.

Math Analyzing Data

Temperature and Solubility



Interpreting Data:

Q. Does solubility increase at the same rate with every 20°C increase in temperature? Explain.

A. No; the curve shows that solubility increases more with each 20°C increase in temperature.

Links on Solubility

Click the SciLinks button for links on solubility.

End of Section: Concentration and Solubility

Section 3: Describing Acids and Bases

- What are the properties of acids and bases?
- Where are acids and bases commonly used?

Properties of Acids and Bases

Litmus is an example of an indicator, a compound that changes color when in contact with an acid or a base.

Uses of Acids and Bases

Acids and bases have many uses around the home and in industry.

Acids in the Home People often use dilute solutions of acids to clean brick and other surfaces. Hardware stores sell muriatic (hydrochloric) acid, which is used to clean bricks and metals.

Uses of Acids and Bases

Acids and bases have many uses around the home and in industry.

Acids and Food
Many of the vitamins in the foods you eat are acids.

Uses of Acids and Bases

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Acids and Food
Many of the vitamins in the foods you eat are acids.

Tomatoes and oranges contain ascorbic acid, or vitamin C.

Uses of Acids and Bases

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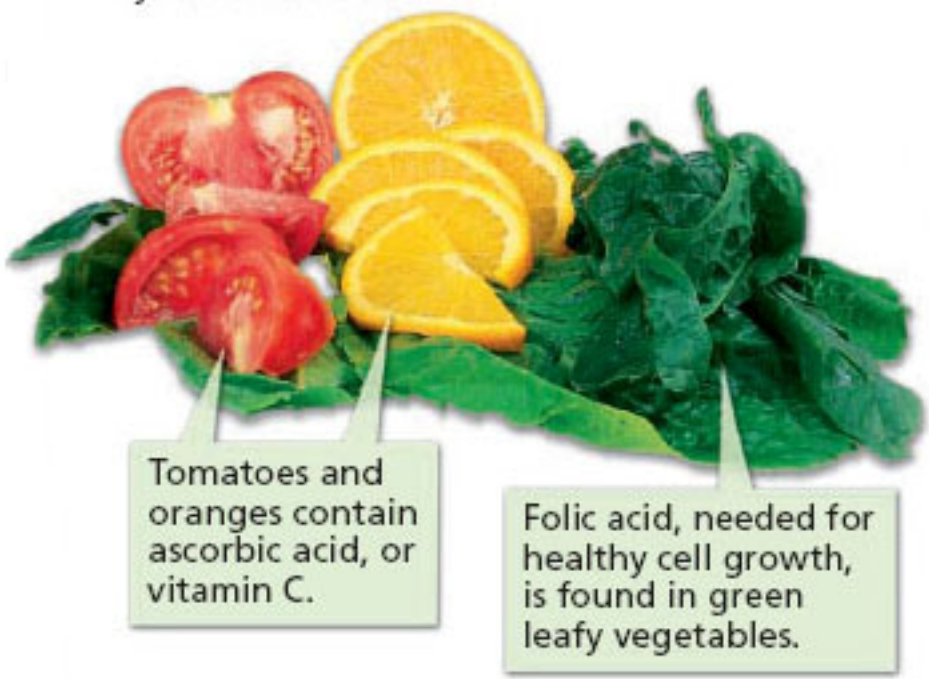
Acids and Food
Many of the vitamins in the foods you eat are acids.



Uses of Acids and Bases

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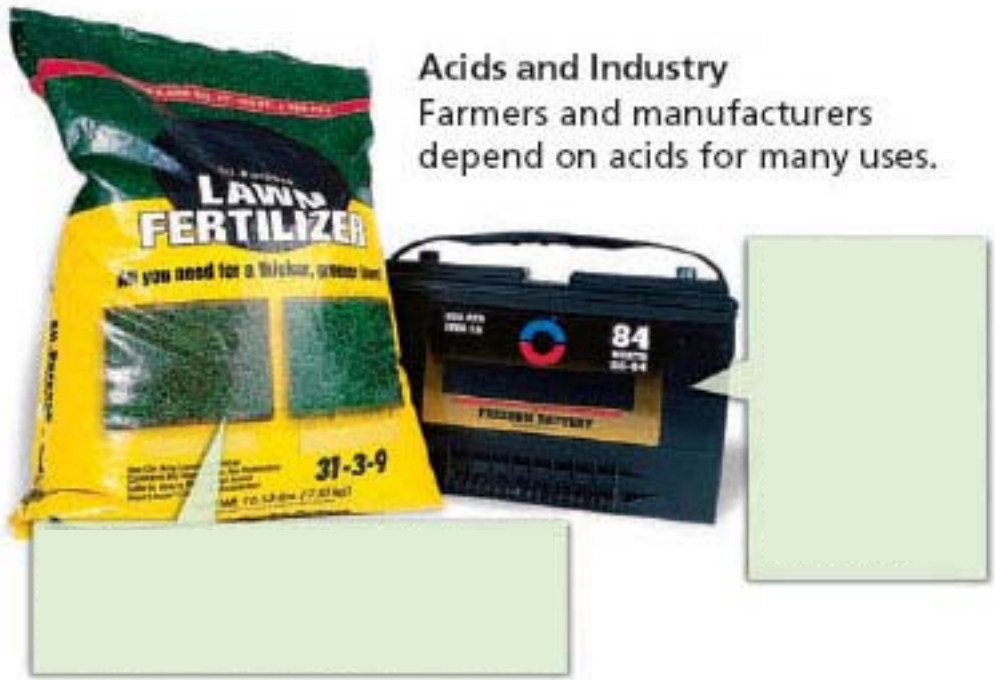
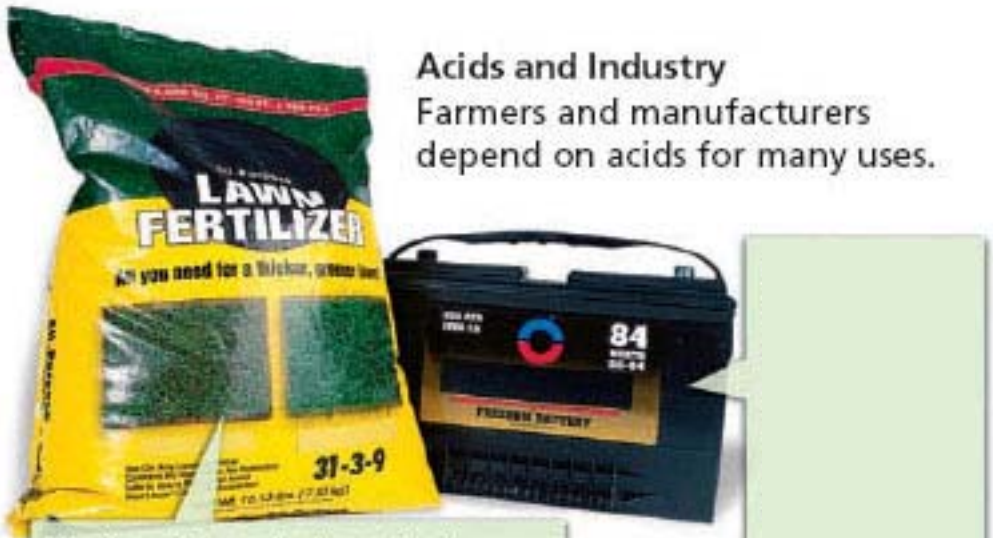


Acids and Industry
Farmers and manufacturers depend on acids for many uses.

Uses of Acids and Bases

Acids and bases have many uses around the home and in industry.



Acids and Industry
Farmers and manufacturers depend on acids for many uses.

Nitric acid and phosphoric acid are used to make fertilizers for crops and lawns.

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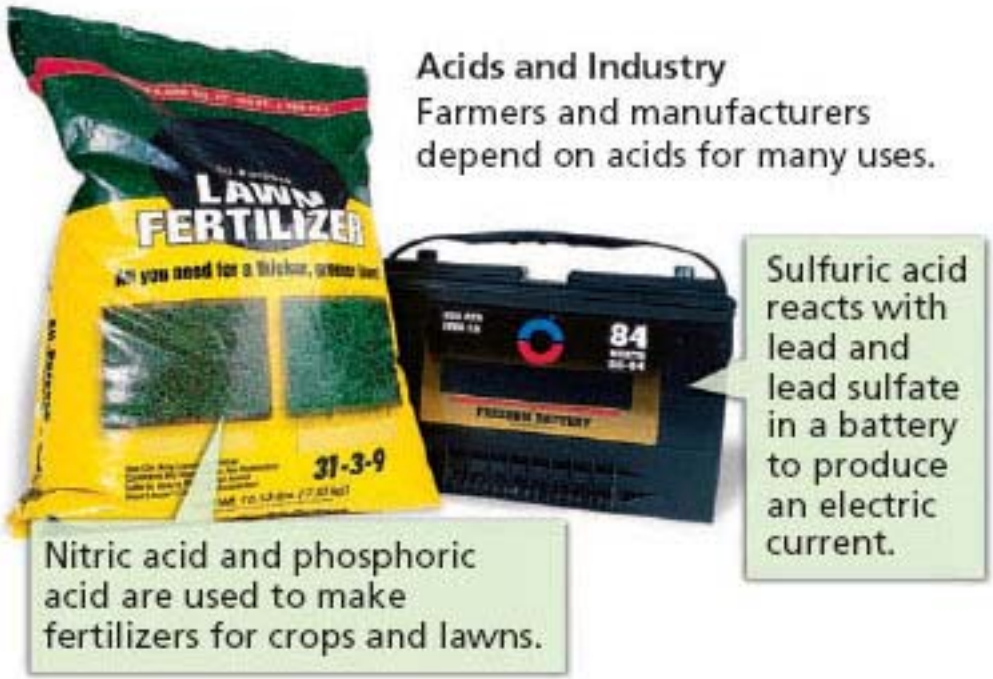

Acids and Industry
Farmers and manufacturers depend on acids for many uses.

Nitric acid and phosphoric acid are used to make fertilizers for crops and lawns.

Sulfuric acid reacts with lead and lead sulfate in a battery to produce an electric current.

Uses of Acids and Bases

Acids and bases have many uses around the home and in industry.

Bases and Industry
Mortar and cement are manufactured using the bases calcium oxide and calcium hydroxide.

Uses of Acids and Bases

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Acids and bases have many uses around the home and in industry.

Bases in the Home
Ammonia solutions are safe to spray with bare hands, but you must wear gloves when working with drain cleaners.

Drain cleaners contain sodium hydroxide (lye).

You can't mistake the odor of household cleaning products made with ammonia.

Uses of Acids and Bases

Acids and bases have many uses around the home and in industry.

Bases and Food
Baking soda reacts with acids such as lemon juice and buttermilk to produce carbon dioxide gas in baked goods. Without these gas bubbles, breads, biscuits, cakes, and cookies would not be light and fluffy.

Links on Acids and Bases

Click the SciLinks button for links on acids and bases.

End of Section: Describing Acids and Bases

Section 4: Acids and Bases in Solution

- What kinds of ions do acids and bases form in water?
- What does pH tell you about a solution?
- What happens in a neutralization reaction?

Acids and Bases in Solution

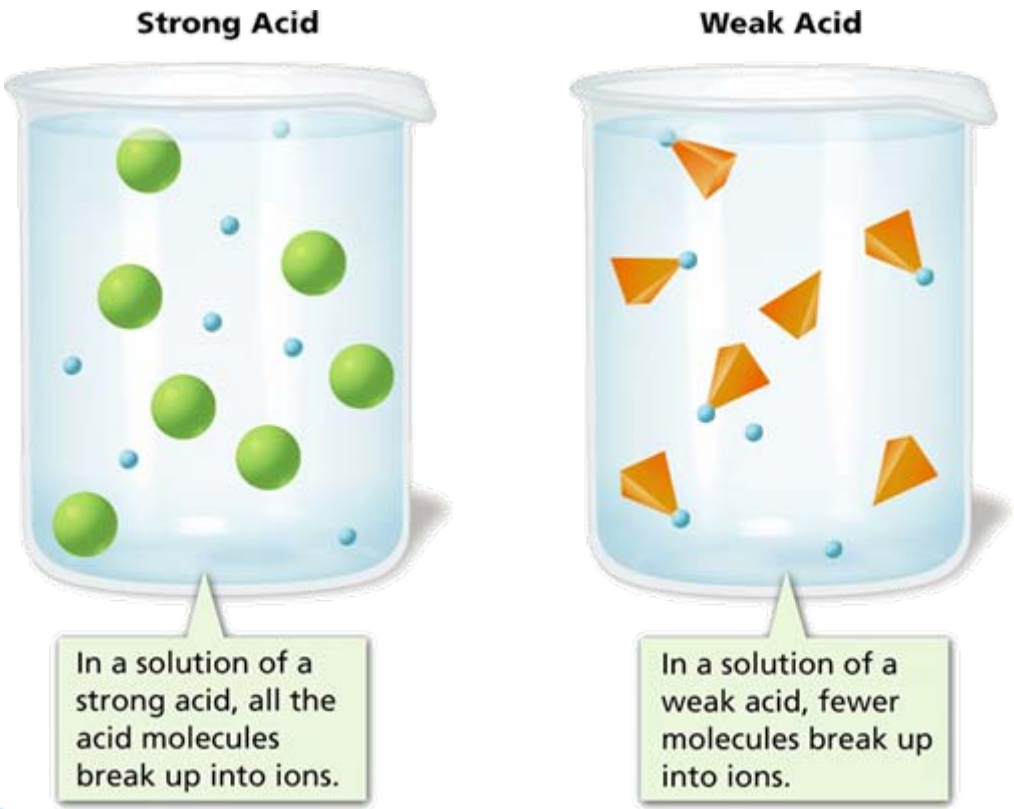
The table lists some commonly encountered acids and bases.

Important Acids and Bases

Acid	Formula	Base	Formula
Hydrochloric acid	HCl	Sodium hydroxide	$NaOH$
Nitric acid	HNO_3	Potassium hydroxide	KOH
Sulfuric acid	H_2SO_4	Calcium hydroxide	$Ca(OH)_2$
Carbonic acid	H_2CO_3	Aluminum hydroxide	$Al(OH)_3$
Acetic acid	$HC_2H_3O_2$	Ammonia	NH_3
Phosphoric acid	H_3PO_4	Calcium oxide	CaO

Strength of Acids and Bases

Strong acids and weak acids act differently in water. Hydrochloric acid is a strong acid. Acetic acid is a weak acid.

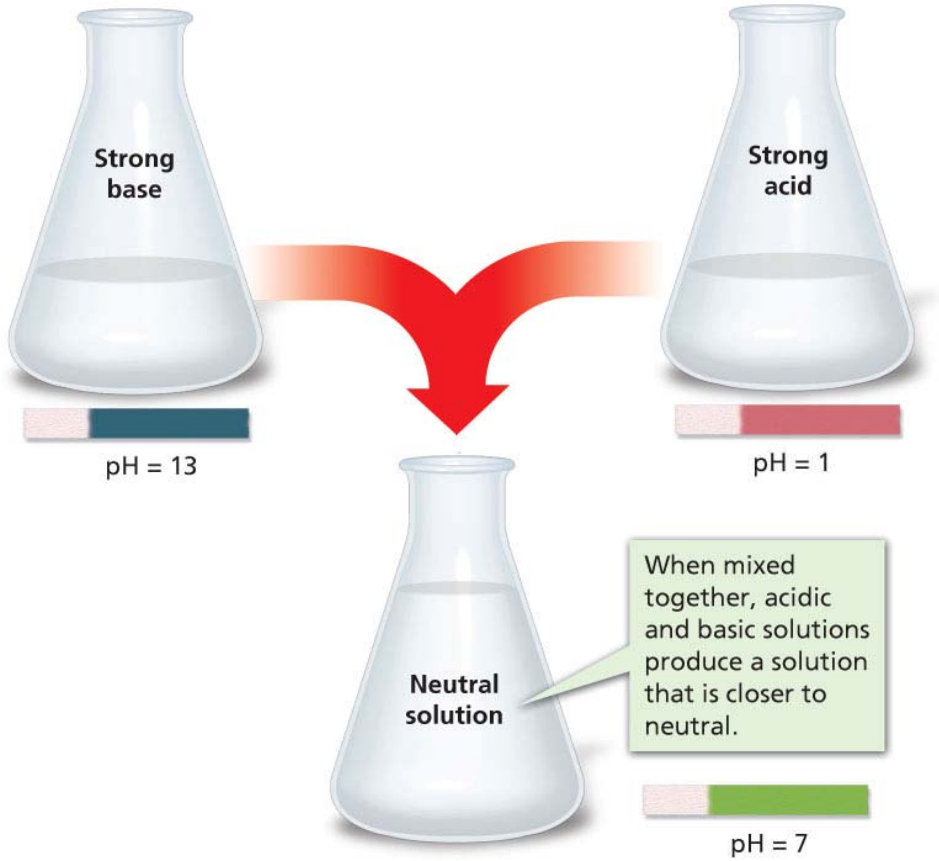


The pH Scale

A low pH indicates that the concentration of hydrogen ions is big. In contrast, a high pH indicates that the concentration of hydrogen ions is low.

Acid-Base Reactions

In a neutralization reaction, an acid reacts with a base to produce a salt and water.



Acid-Base Reactions

Common Salts	
Salt	**Uses**
Sodium chloride NaCl	Food flavoring; food preservative
Potassium iodide KI	Additive in "iodized" salt that prevents iodine deficiency
Calcium chloride $CaCl_2$	De-icer for roads and walkways
Potassium chloride KCl	Salt substitute in foods
Calcium carbonate $CaCO_3$	Found in limestone and seashells
Ammonium nitrate NH_4NO_3	Fertilizer; active ingredient in cold packs

Each salt listed in this table can be formed by the reaction between an acid and a base.

More on the pH Scale

Click the PHSchool.com button for an activity about the pH scale.

pH

Click the Video button to watch a movie about pH.

End of Section: Acids and Bases in Solution

QuickTake Quiz

Click to start quiz.