CHAPTER 4

Solutions and the

Getting Ready...

- How does varying the amount of solute affect a solution?
- How does the concentration of a product affect the amount of packaging?
- What are acids and bases?
- What is pH?
- Does the salt placed on icy roads do harm as well as good?

Science Log

Look for an ad that mentions the term "pH." If you can, cut out the ad and paste it into your Science Log. Otherwise, describe the ad in your Science Log. As you learn about pH, consider what point the ad is trying to make.

What do these pictures have in common?

The answer is that they all have something to do with chemistry.

Think about how you use shampoo. You would never think of shampooing your hair without adding water, because shampoo is a concentrated solution. You need to add water to use it effectively.

Many products are sold as concentrates. Does that matter?

It does to the environment. Concentrated products need less packaging. Less packaging cuts down on waste.

Chemistry also helps to explain why it is better to wash your hair with shampoo than with soap. Shampoo is a weak acid. Later in this chapter, you will learn why using an acid shampoo is important in keeping your hair healthy.

Acids can be useful, but they can also have harmful effects. Factories that make shampoo and other products release fumes that can mix with moisture in the air to make acid rain. By the end of this chapter, you will understand how people use chemistry to simplify their lives and protect the environment.

Environment

What You Will Learn

In this chapter you will learn:

- about the differences between concentrated and dilute solutions
- how using concentrated solutions can help the environment
- how to identify acids and bases
- how to interpret pH
- about the factors that affect corrosion

Why It Is Important

- If you wash your hair with soap instead of shampoo, your hair will appear dry and dull. Shampoo is a weak acid. Soaps are usually weak bases. Since hair is slightly acidic, it feels more natural when it is washed with a product that is similar to it.

Skills You Will Use

In this chapter you will:

- distinguish between a concentrated and a dilute solution
- compare the amount of waste packaging from various products
- use indicators to identify acids and bases
- classify substances as acids and bases
- investigate factors that affect corrosion

Starting Point

ACTIVITY

Tea Time

Can you tell how much sugar or lemon your tea contains just by observation?

Safety Precautions

What You Need

3 clear plastic cups or beakers

boiling water

1 tea bag

5 mL sugar

5 mL lemon juice

stirrer

What to Do

1. Label the plastic cups 1, 2, and 3. Fill each cup three quarters full with boiling water.
2. Place the tea bag into the first cup for 2 minutes. Place the same tea bag into the second cup and then the third, each for 2 minutes.
3. Note and record any differences between the three cups of tea.
4. Add 5 mL of sugar to the second cup and stir until the sugar is dissolved. Do your observations from Step 3 change?
5. Add 5 mL of lemon juice to the first cup and stir. Do your observations change?

4.1 Use Concentrated Solutions to Reduce Garbage

Figure 4.1 Concentrated products are convenient because they are easy to transport and store until needed. They also require less packaging. Which of these products is concentrated? Which is dilute?

How does your family buy orange juice? From the refrigerator section as a 1 L container? Or in the freezer section in a small can that you thaw and mix?

If you use frozen juice or juice crystals, you are using a **concentrated** product. Concentrated products have a lot of solute per volume of solvent. To make juice from concentrate, you need to add water. The result is a tasty mix of solute and solvent.

Large containers of ready-made juice are the opposite. They have less solute per amount of solution. Such solutions are called **dilute** solutions. You can drink dilute juice right from the package, or after adding a small amount of water. Dilute solutions have a high water content. They require more packaging to hold this amount of water. The product could be concentrated and packed in a smaller container, thus reducing packaging.

READING Check

Which has more solute, a cup of concentrated apple juice or one of dilute apple juice?

How Are Concentrated Products Made?

Like most of us, you probably use a lot of concentrated products. These include instant coffee, canned soups, soup mixes, packaged salad dressings, and dehydrated refried beans for burritos.

Think about these items. What do they all have in common?

If you said they come in small packages, you are right. And if you said they are dry or really thick, you are right again.

Concentrated products are dry or thick because they are made by removing some or all of the solvent. Before using them, we need to replace that solvent.

In most cases, the solvent is water. In some cases, such as salad dressing, the solvent may be oil or vinegar.

DidYouKnow?

The strength of concrete is directly related to the amount of water that was used in the mix. The more concentrated the mix, the stronger the concrete will be.

READING Check

When making a concentrated product, do you reduce the amount of solute or solvent?

SKILLCHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

How Much Packaging?

Think About It

Does buying concentrated products really reduce the amount of packaging? Are there any other benefits of buying concentrated products? Use the following information to find out.

	Mass of Packaging (g)	Volume of Prepared Juice (mL)	Servings of Prepared Juice	Total Cost of Juice ($)
frozen concentrate	33.66	1364	5.5	1.20
drinking boxes	78.72	1500	6	2.58

What to Do

1. With a partner, examine the data provided in the table.
2. Calculate the mass of garbage each product will produce per serving (g/serving).

$$\text{Mass of package per serving} = \frac{\text{mass of packaging}}{\text{number of servings}}$$

3. For each product, calculate the cost of the juice per serving.

$$\text{Cost per serving} = \frac{\text{total cost}}{\text{number of servings}}$$

Which product uses less packaging per volume?

Analyze

1. Which product has less packaging per serving?
2. Which product costs more per serving?
3. With your partner, brainstorm the pros and cons of buying each product. Use a chart to record the pros and cons.
4. Which product will have the least impact on the environment?

Internet CONNECT

www.mcgrawhill.ca/links/science.connect1

Drinking boxes are made from a plasticized cardboard carton called a Tetra Pak™. Research how this packaging can be recycled and what products it can be made into. Go to the above web site, then to Internet Connects, Unit A, Chapter 4, and then to Drinking Boxes.

Waste Packaging

READING Check

What kinds of packaging might be desirable even though they create waste?

Every day, each person in Canada throws out about 2.2 kg of trash. That is enough to fill 10 000 garbage trucks. Where does all that garbage come from?

Paper and yard waste make up a large percentage. So do food scraps, metals, glass, and plastics. About 30 percent of the garbage in landfills is product packaging such as plastic wrap, cardboard, and tin.

Not all packaging is wasteful or undesirable. Some packaging protects food products from contamination and spoilage. Other packaging protects fragile products during shipping. Packages also provide valuable consumer information, and some products have special child-proof packages to prevent children from being poisoned.

But landfills across Canada would last longer if they were not filling up with so much waste packaging. In Unit D, you will learn how you can reduce, re-use, and recycle to help. This unit emphasizes the advantages of buying concentrated products.

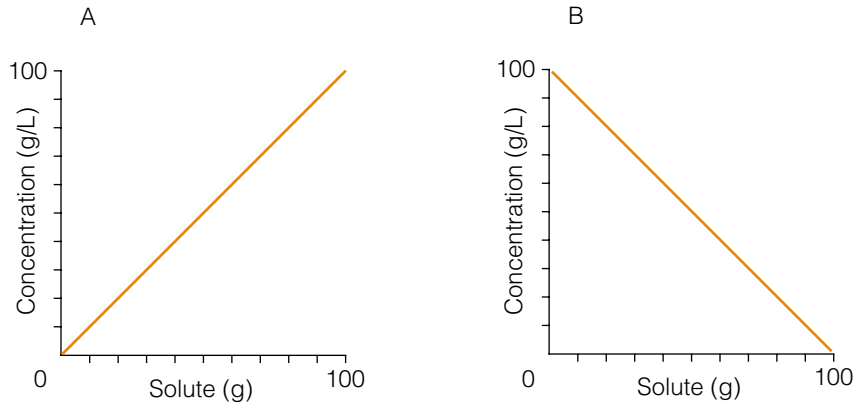
Figure 4.2 The average Canadian family produces about 62 kg of garbage every week. How do concentrated products reduce the volume of garbage?

Key Terms

concentrated
dilute

Check Your Understanding

1. Describe how to make a dilute solution from a concentrated solution.
2. Both of these graphs show the concentration of a solution. Which shows a solution that is becoming more concentrated? Explain.



3. Why do you mix coffee powder with boiling water when making instant coffee?
4. State two advantages of buying concentrated products rather than dilute products.

4.2 Acids and Bases

Vinegar cleans the stains from a coffee decanter. Soap slips out of your hand. Battery fluid will burn your skin and eat a hole in your clothes. Antacids eliminate heartburn.

What do these substances have in common? They belong to a group of substances called acids and bases.

- An **acid** is a corrosive, sour-tasting substance that turns blue litmus paper red.
- A **base** is a slippery, bitter-tasting substance that turns red litmus paper blue.
- Substances that are neither acids nor bases are **neutral**. When you neutralize an acid or base, you make it neutral.

Figure 4.3 All of these products belong to a group of substances called acids and bases.

Table 4.1 Common Acids and Bases and Their Uses

	Name	Uses
Acid	hydrochloric acid	• to etch concrete before painting • as a toilet bowl cleaner
	sulfuric acid	• to make plastics, fertilizers, and dyes • in car batteries to conduct electricity
	vinegar (acetic acid)	• cooking • as a preservative
Base	ammonia	• household cleaning • in fertilizers and explosives
	baking soda (sodium bicarbonate)	• makes cookies, cakes, etc. rise in the oven • as an antacid
	sodium hydroxide	• in drain and oven cleaners • to make soaps and detergents

DidYouKnow?

Svante Arrhenius was a Swedish chemist who defined acids and bases in his doctoral examination in 1884. Because other chemists rejected his theory, he barely passed his exam. Eventually, chemists realized that Arrhenius had a good theory. He was awarded the Nobel Prize in Chemistry in 1903.

READING Check

Are sour gumdrops more likely to be an acid or a base?

Try This!

Add some baking soda to a small amount of cranberry juice in a glass. What happens to the colour of the cranberry juice?

Baking soda is a base. What do your observations suggest about how cranberry juice acts with bases?

Properties of Acids and Bases

In Chapter 1, you learned that physical and chemical properties allow scientists to identify and classify matter. You already know that bases taste bitter and acids taste sour. However, scientists do not rely on this property in order to identify acids and bases.

By repeated investigation, scientists have discovered other properties of acids and bases. This allows substances that are too dangerous to touch or taste (such as battery acid) to be classified. Table 4.2 lists some properties of acids and bases.

Table 4.2 Properties of Acids and Bases

Acids	Bases
• taste sour	• taste bitter
• change litmus paper from blue to red	• change litmus paper from red to blue
• react with metals	• feel slippery
• pH less than 7	• pH more than 7
• corrosive	• corrosive
• neutralize bases	• neutralize acids
• conduct electricity	• conduct electricity

READING Check

Why are indicators useful for identifying acids and bases?

Identifying Acids and Bases

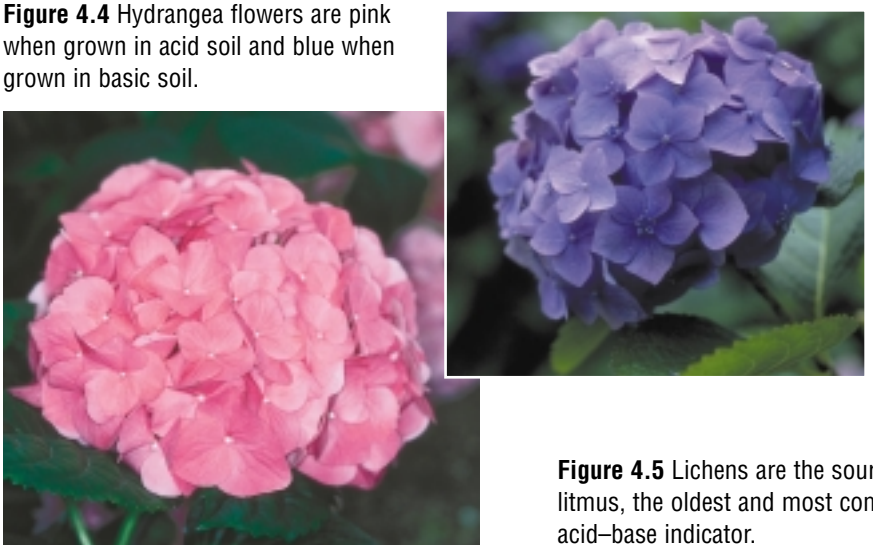
Scientists identify acids and bases using indicators. An **indicator** is a natural substance that changes colour in the presence of an acid or base.

Some flowers are indicators. They change colour depending on the acidity of the soil. Lichens, cabbage juice, tea (remember the Starting Point activity), and grape juice will also change colour in the presence of an acid or base.

The most reliable way to identify an acid or a base is to use an indicator such as litmus, which is a dye made from lichen.

Litmus paper is a convenient indicator strip that has been treated with a weak solution of litmus. In the next investigation, you will use litmus paper to identify common substances as either acids or bases.

Figure 4.4 Hydrangea flowers are pink when grown in acid soil and blue when grown in basic soil.



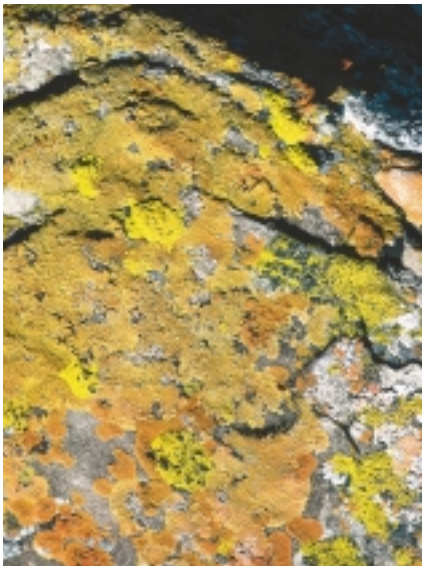


Figure 4.5 Lichens are the source of litmus, the oldest and most common acid–base indicator.

A Scale for Classifying Acids and Bases

A substance's **pH** tells you how acidic or basic it is. Knowing the pH of a substance helps you use it safely and effectively.

Chemists have developed a scale that classifies how acidic or basic substances are. This **pH scale** classifies substances from 0 to 14.

- Acids have a pH of less than 7.
- Bases have a pH greater than 7.
- Substances that fall in the middle of the scale are neither acidic nor basic. They are neutral.

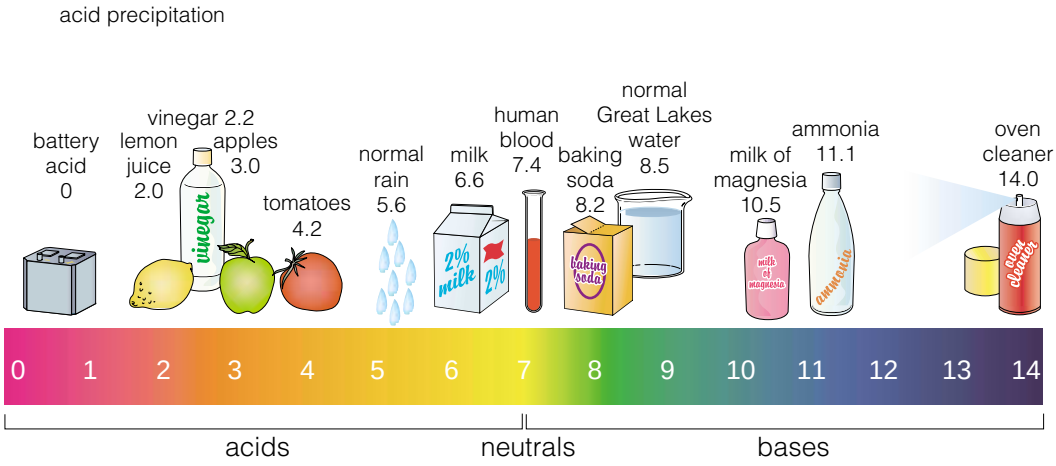


Figure 4.6 pH Scale

Find milk on the pH scale in Figure 4.6. The pH of milk is very close to neutral.

Now move your finger to the left of the scale. As you get closer to 0, the substances get more acidic. As you move your finger toward 14 on the scale, the substances get more basic.

What is the pH of vinegar? Is it more or less acidic than milk?

In Conduct an Investigation 4–B, you will use indicators to measure the pH of several household substances.

READING Check

Explain what the pH of a substance tells about it.

DidYouKnow?

Stomach acid is corrosive enough to burn a hole through your stomach. So why doesn't this happen? Your stomach has a slimy, protective layer of mucus. Stomach ulcers form when this layer fails, allowing acids to eat away (digest) the stomach wall.

Disc CONNECT

Can you identify acids and bases in your home? What does the pH scale measure? Are there laboratory tests that you can perform to determine if a substance is an acid or a base? To answer these and other questions, load the student CD-ROM onto your computer. Launch the **Acids** applet and follow the instructions.

CONDUCT AN

INVESTIGATION 4–B

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Acids and Bases Around You

In this activity, you will use litmus paper to test whether a mixture is an acid or base. Then you will use universal pH paper to determine the exact pH of the mixture.

Litmus paper changes colour depending on the substance being tested. This happens because the indicator changes to different colours depending on the pH of the substance.

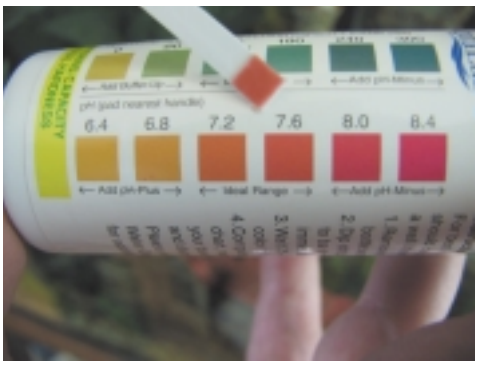
- Blue litmus paper changes colour only in the presence of an acid. It will stay the same colour if it is mixed with a base.
- Red litmus paper changes colour in the presence of a base. It will stay the same colour when mixed with an acid.

Universal pH paper is unique because it changes colour throughout the pH scale. It changes a different colour for each pH.

As you work through this investigation, note what happens to both litmus paper and universal pH paper when a mixture is neutral.

Problem

Which common household solutions are acids? Which are bases? What is the pH of each?



You can determine the pH of a substance by matching the colour the universal pH paper changes to with the colour key that comes with the paper.

Safety Precautions

- Never taste anything in the lab or touch an unknown substance with your bare hands.
- Dispose of substances as directed by your teacher.
- Inform your teacher of any spills immediately.
- When you have finished the investigation, wash your hands thoroughly and clean up the work area as directed.

Apparatus

glass stirring rod

colour key for universal pH paper

Materials

ammonia

9 other household mixtures

blue litmus paper

red litmus paper

universal pH paper

paper towels

water

Procedure

Part 1: Is It an Acid or Base?

Substance	Prediction	Red Litmus Paper	Blue Litmus Paper	Colour Change	pH According to Scale	Acid, Base, or Neutral?

1. Draw a chart in your notebook similar to the one shown here.
2. In the first column, write the name of each substance you will investigate, starting with ammonia.
3. Predict whether each substance is an acid, a base, or neutral. Write your prediction in the "Prediction" column.
4. Use the stirring rod to apply one drop of ammonia to a piece of red litmus paper.
5. Wait 60 sec, and then record the colour of the litmus paper in the "Red Litmus Paper" column.
6. Use the stirring rod to apply one drop of ammonia to a piece of blue litmus paper.
7. Wait 60 sec, and then record the colour of the litmus paper in the "Blue Litmus Paper" column.
8. Clean the stirring rod with water and a paper towel.
9. Repeat Steps 4 to 8 with each of the remaining substances.

Part 2: What Is the pH?

10. Using the clean glass stirring rod, place a drop of ammonia on a piece of universal pH paper.
11. Once the paper changes colour, note the colour in the "Colour Change" column of your table.
12. Compare the colour change to the colours on the key provided. Estimate and record the pH of the substance in the "pH According to Scale" column of your table.
13. Rinse the stirring rod with tap water and dry it with a paper towel.
14. Repeat Steps 10 to 13 with the remaining samples.
15. Discard the solutions and indicators as directed, and wash your hands thoroughly.

Analyze

1. Use this chart to analyze your results and complete the "Acid, Base, or Neutral?" column of your data chart.

	Blue Litmus Paper	Red Litmus Paper
acid	turns red	stays red
base	stays blue	turns blue
neutral	stays blue	stays red

2. Which of your predictions proved to be accurate?

3. Did any results surprise you? If so, which ones? Why?

4. Draw and label a scale from 0 to 14.

(a) On the scale, label the pH of each of the substances you tested.

(b) Compare the pH scale you have made to the scale of a classmate. Explain any differences.

5. List the substances you tested in order of pH, beginning with the most acidic.

DidYouKnow?

Even water can be dangerous if it is mixed with an acid. If water is added to concentrated sulfuric acid, the mixture can get so hot that it can even boil, splashing the dangerous acid out of the container. When diluting acids, always add the acid to the water, not the other way around.

DidYouKnow?

Some acids are important to your health. Ascorbic acid (vitamin C) helps build bones, teeth, and cartilage.

6. (a) What is the pH of the ammonia you tested?

(b) How do your results compare to the pH of ammonia given in Figure 4.6 on page 65?

Conclude and Apply

7. Why do you need to test with both red and blue litmus paper in order to identify substances as being acids, bases, or neutral?

8. What colour will universal pH paper become when testing the following substances?

(a) ant bite, pH 3.0

(b) rainwater, pH 5.6

(c) blood, pH 7.4

9. The pH of safe swimming pool water is between 7.2 and 7.8. When you use universal pH paper to test the water in the swimming pool, the strip turns a yellow-green colour.

(a) Is the water acidic or basic?

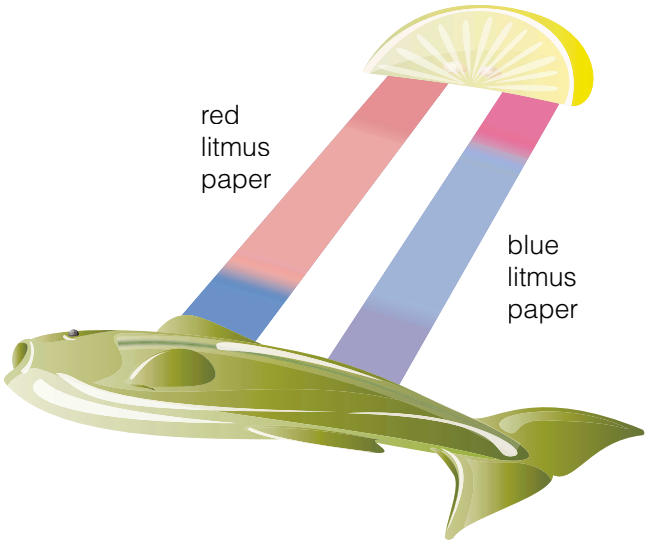
(b) Is the water safe for swimmers? Explain.

10. (a) What is the different between litmus paper and universal pH paper?

(b) Give an example of when you would use each indicator.

red | blue
acid | base

Like all acids, lemon turns the blue litmus paper red, but does not change the colour of red litmus paper. Like all bases, fish oil turns red litmus paper blue, but does not change the colour of blue litmus paper.



Career CONNECT

Before concrete can be painted or sealed, it must be etched (roughed up) with an acid. The acid dissolves a thin topcoat of the concrete, leaving a rough, clean surface for the paints and stains. Concrete finishers rely on their knowledge of acid and base reactions to control the size, shape, and depth of this etched layer.

Today, etching is used to add colour and texture to floors, swimming pools, concrete countertops, buildings, and artwork.

To become a qualified concrete finisher, you need to apprentice under a qualified employer. Though a high school diploma is preferred, you may enter an apprenticeship program while still in school. The program takes three years. It includes eight weeks of classroom sessions combined with training on the job. To get a Journeyman Certificate, you must successfully complete the apprenticeship and required tests.

Figure 4.7 This compass design is made from concrete. Concrete finishers use their knowledge of acids and bases to prepare concrete products for painting or staining.

DidYouKnow?

Hair has a natural pH of about 5. Shampoo with about the same pH keeps hair healthy and shiny. Soap does not produce the same results because it is a base and dries out hair.

Try This!

Find out what colour red cabbage juice changes when mixed with lemon juice and ammonia. What other substances can you try? Use the results to develop your own indicator strip.

Check Your Understanding

1. List three properties of acids.
2. Name one substance that you might use as an indicator. Use a diagram to show the colour change that occurs.
3. An unknown solution was tested with litmus paper. Red litmus turned blue, and blue litmus stayed blue. Is the substance an acid or a base?
4. Classify the following solutions as acids, bases, or neutral.
   (a) household bleach, pH 12.4
   (b) urine, pH 6.0
   (c) black coffee, pH 5.0
   (d) sugar water, pH 7
   (e) egg white, pH 7.8

Key Terms

- acid
- base
- neutral
- indicator
- litmus paper
- pH
- pH scale

4.3 Acids and Bases in Action

READING Check

How does neutralization help lemon juice eliminate fishy odours?

What makes a cake rise? How does an antacid cure heartburn? Why does baking soda keep your refrigerator smelling fresh? Learning about the reactions of acids and bases will help you answer each of these questions.

Baking — Many recipes call for sour milk. Cooks often sour milk by mixing vinegar or lemon juice into it. When baking soda (base) and sour milk (acid) mix, they quickly form a frothy mass. The reaction releases carbon dioxide gas in the form of bubbles. This reaction makes pancake, cookie, and cake dough rise.

Cooking — In the past, cooks used trial and error to find how best to cook various foods. Today's chefs work in test kitchens to investigate the best cooking methods. Through careful study, they have found that the pH of the cooking liquid affects the colour and texture of cooked vegetables. Vegetables cooked in an acidic mixture take longer to cook and do not soften. Those cooked in a basic mixture soften more easily. That is why chefs often add baking soda to dried beans before cooking them.

Health Care — Heartburn occurs when too much acid is produced in your stomach. To treat heartburn, you could take an antacid tablet. Antacids are bases that help neutralize the acid in your stomach. When an acid and a base combine, they cancel out each other's properties. The result is a neutral substance. This chemical reaction is called **neutralization**.

Deodorizing — Neutralization helps baking soda remove odours from a refrigerator. Baking soda (a base) cancels out acidic food odours.

Combining acids and bases can be useful. It can also be dangerous. In Chapter 1, you learned never to mix bleach with an acid or base. That is because bleach forms deadly fumes when mixed with either an acid (such as toilet bowl cleaner) or a base (such as ammonia).

Try This!

To clean clogged drains, pour 125 mL of baking soda into the drain. Add 25 mL of vinegar and a kettle-full of boiling water. What happens when vinegar and baking soda mix? How would this clean a clogged drain?

Figure 4.8 The right balance of acids and bases in aquarium water helps keep fish healthy.

Corrosion

Substances found near either end of the pH scale are highly **corrosive**. This means that they can cause severe burns to skin and other body tissues. They can even eat through substances such as metal or rock.

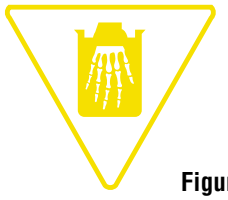


Figure 4.9

Sulfuric acid can be found near one end of the pH scale, at about 0. Drain cleaner is near the other end. Both are highly corrosive. How might being corrosive help a drain cleaner to work?

What Affects Corrosion?

Corrosion is the wearing away of materials by chemical action. It is also known as rusting. Oxygen is the primary cause of this chemical reaction. Substances such as acid rain and salt speed up the process. Study the pictures and captions below to learn more about corrosion.

READING Check

What role does humidity play in corrosion?

Figure 4.10 The marks on these leaves are a result of acid rain. **Acid rain** is a term that describes any precipitation that has a pH lower than 5.6. Today, many buildings, vehicles, and other structures are being corroded by acid rain. It is a problem because we burn a lot of fossil fuels. When fossil fuels are burned, they release pollutants that react with water in the air to form acidic rain, snow, or fog. Acid rain does not feel or taste any different than ordinary rain. Unfortunately, it can corrode substances (such as metal or stone surfaces) and living matter (such as leaves).

Figure 4.11 Areas near large bodies of water tend to be very humid, because there are a lot of water droplets in the air. Corrosive substances (such as salt from seawater) dissolve in these tiny water droplets. The water and corrosive substances form a solution that coats surfaces such as cars, buildings, and ships. This coating speeds up corrosion.

Figure 4.12 Think back to the particle theory you learned about in Chapter 1. As particles heat up, they move faster and collide more. These increased collisions speed up all chemical reactions. Because corrosion is a chemical reaction, high temperatures will increase the rate of corrosion. Which of these cars will corrode faster — the one inside a heated garage or the one outside in the cold?

Figure 4.13 When copper corrodes, it turns green. Silver corrosion is black. Which metal was used on the roof of the parliament buildings?

Corrosion at Work

Corrosion accounts for many things, including the colour of minted coins. When they come fresh from the mint, coins have bright silver or copper colours. With exposure to air, sweat, and other substances, they become dull and discoloured. The colours they turn depend on the metals from which they were made.

Silver turns black when it corrodes. Few of today's coins have much silver in them, but sterling silver does. Some silverware and jewellery are made from sterling silver. That is why some good silverware turns black. People polish silver to remove the corrosion.

Off the Wall

Some metals, such as aluminum, do not seem to corrode. Actually, aluminum corrodes very quickly. The corrosion forms a thin, transparent layer on the surface of the metal. This layer isolates the aluminum from oxygen in the air and protects the metal from corroding further. You have to look carefully to see it.

Figure 4.14

Try This!

Place three pennies in a bag with a paper towel soaked in vinegar. Look at them five days later. What happened to the pennies? What does this suggest about how acids (vinegar) react with metals?

READING Check

Describe how one metal is affected by corrosion.

Internet CONNECT

www.mcgrawhill.ca/links/science.connect1

To learn more about how acid rain speeds corrosion, go to the above web site, then to Internet Connects, Unit A, Chapter 4, and on to Acid Rain.

Find Out ACTIVITY

What Corrodes Steel Faster?

In this activity, you will compare the corrosive effects of salt, an acid, and a base.

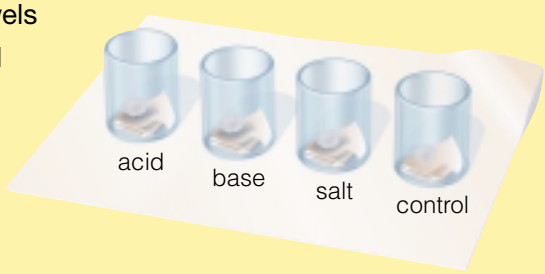
SKILL CHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Safety Precautions

- Wash your hands thoroughly at the end of each day.

What You Need

4 plastic cups or glass beakers
paper towels
steel wool
table salt
tap water
vinegar
ammonia



What to Do

1. Place a paper towel and a small piece of steel wool into each cup.
2. Pour enough vinegar into the first cup to soak the paper towel. Label this glass "acid."
3. Add a similar amount of ammonia to the second cup. Label it "base."
4. Dissolve 10 g of table salt in 20 mL of water. Pour this salt-water solution into the third cup, soaking the paper towel. Label this cup "salt."
5. Label the fourth cup "control."
6. Make sure each piece of steel wool is exposed to air and touching the paper towel. Record your observations.
7. Set the samples aside for 24 h, then observe the contents again. Record your observations.

What Did You Discover?

1. What changes did you observe after 24 h?
2. What evidence of corrosion did you observe?
3. Was there a difference between the pieces of steel wool in each of the cups? Explain.
4. Which substance caused faster corrosion?

Check Your Understanding

1. Sponge toffee is made by mixing sugar, corn syrup, vinegar, and baking soda. Why do bubbles form in sponge toffee?
2. Should you clean up an acid spill with water or with a base? Explain.
3. Why would you want to wash your car after driving on salted winter roads?
4. Explain why car battery terminals corrode.
5. Would you expect to do more repair work to a bridge in a humid coastal city or in a dry inland city? Explain your choice.
6. How can you protect materials in bridges, ships, and cars from corroding? Brainstorm with your group, and then research the options by checking magazines, searching the Internet, or asking at hardware, automotive, and marine stores. Report your findings to the class.

Key Terms

neutralization
corrosive
corrosion
acid rain

Computer CONNECT

Use a word processor to write your report or generate a presentation.

CHAPTER

4 Review

Key Terms

concentrated
dilute
acid
base
neutral
indicator
litmus paper
pH
pH scale
neutralization
corrosive
corrosion
acid rain

Reviewing Key Terms

If you need to review, the section numbers show you where these terms were introduced.

1. Describe the difference(s) between the following terms.
   (a) concentrated and dilute (4.1)
   (b) acid and base (4.2)
2. How do bases affect litmus paper? (4.2)
3. Develop a short script describing the pH scale to a friend who has not studied science. (4.2)
4. Define "neutralization." (4.3)
5. Explain how rust is an example of corrosion. (4.3)

Understanding Key Ideas

Section numbers are provided if you need to review.

6. Your cousin likes to drink tea with one spoonful of sugar. Her mother likes three spoonfuls of sugar in her tea. Who prefers the more concentrated sugar–tea solution? (4.1)

7. Draw a graph showing what happens to the amount of solute as the concentration of a solution decreases. (4.1)
8. Which produces more waste packaging, a concentrated product or a ready-to-use product? (4.1)
9. Copy the following chart into your notebook. Complete the other three columns of the chart by putting check marks in the appropriate boxes.

	True for Acids Only	True for Bases Only	True for Both Acids and Bases
(a) sour taste (4.2)			
(b) bitter taste (4.2)			
(c) speeds up corrosion (4.3)			
(d) soaps are an example (4.2)			
(e) can be detected with an indicator (4.2)			
(f) is often corrosive (4.3)			

10. Why do scientists use indicators to identify acids and bases? (4.2)
11. Is an apple with a pH of 3 an acid or a base? (4.2)
12. Fish oil is a smelly base. How could lemon juice be used to eliminate the smell? (4.3)

13. List four factors that affect corrosion. (4.3)

14. Explain the relationship between acids and corrosion. (4.3)

Developing Skills

15. If you did not have a commercial indicator such as litmus paper, what substance could you use to classify a solution as either an acid or a base? (4.2)

16. Copy this table into your notebook, and then complete the last column. Explain why you made each decision. (4.2)

Substance	pH	Acid or Base?
(a) tomatoes	4.2	
(b) lye	13.8	
(c) stomach acid	2.0	
(d) bananas	5.2	
(e) blood	7.4	
(f) milk of magnesia	10.5	
(g) ammonia	11.1	
(h) eggs	7.8	

17. Draw and label a pH scale that shows where acids, bases, and neutral substances are located. (4.2)

Problem Solving/Applying

18. The last step in manufacturing instant coffee involves removing the solvent. This leaves only the solute to be packaged and sent to stores. What is the advantage of buying a product with very little or no solvent? (4.1)

19. While performing an investigation, a student found that a solution changed the colour of copper and turned blue litmus paper red. Was the solution an acid or a base? (4.2)

20. Wayne is experiencing acid indigestion (heartburn). He does not have a commercial antacid product, but does have baking soda. Will it help his heartburn? Explain. (4.2)

21. List two realistic ways you could reduce the amount of garbage you throw out. (4.1)

22. In each of these statements, which of the following would have a greater corrosive effect? (4.3)
    (a) Rain with a pH of 3.2 or rain with a pH of 5.2.
    (b) Storing a car in a heated garage or in a non-heated garage during the winter.
    (c) Living on the coast or near a desert.

Critical Thinking

23. Draw a flowchart to describe how frozen concentrated orange juice could be made. Begin with whole oranges, and end with the frozen concentrate. (4.1)

24. When ants bite, they inject a venom that is an acid. Use what you know about acids and bases to suggest a treatment that would reduce the pain of such a bite. (4.2)

Pause & Reflect

1. How do the things you buy affect your environment? With a partner, brainstorm some ways your actions could reduce acid rain and the amount of garbage you throw out.
2. Review the Getting Ready questions on page 58 and list the concepts you learned about in this chapter. Draw a flowchart, concept web, or other organizer to explain the links between these concepts.

unit A PROJECT

SKILLCHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Detergent Dilemma

Advertisers promote one brand of detergent over another. But are their claims accurate? Even if they are, how do you decide among the many options?

In this activity, you will use what you learned in the unit to design an investigation that will help you decide which detergent works the best.

Challenge

Design an investigation that will determine how well different detergents remove stains.

Safety Precautions

- Contact with laundry detergents can irritate your eyes, lungs, and stomach.

Materials

large jar

variety of materials to make stains (such as ketchup, grass, mustard, raspberry juice)

fabric

thermometer

variety of detergents

water

Design Criteria

A. Test at least three different detergents.
Note: Be sure the detergent solutions are prepared as directed on the product's packaging. You need to test the effectiveness of each product at the concentration recommended by the manufacturer.

B. Use the same washing conditions for each detergent.

C. Include the following:

- a problem statement;
- a list of apparatus, materials, and safety precautions; and
- a detailed procedure.

D. Outline the criteria you will use to determine how well each stain was cleaned.

Plan and Construct

1. With your group, determine the washing conditions for your test.
   (a) What temperature will the water be? Include instructions for reaching this temperature.
   (b) How will you agitate the laundry? For example, you might use a jar that can be shaken or stir the mixture in a larger container such as a pail.
   (c) How *much* will you agitate the laundry? Include instructions on:
   - how long the sample will be agitated,
   - whether it will be shaken or stirred, and
   - how vigorous the agitation will be.

2. Based on your decisions in Step 1, write out the problem you will investigate. For example, "Which detergent removes stains best in cold water with gentle agitation?"

3. What type of container will you use? Add this to the list of apparatus.

4. What type of fabric(s) will you use? You might choose a natural fabric (such as cotton) or a synthetic (such as polyester). Or, you could test a variety of fabrics. Make a decision and add the item(s) to your list of materials.

5. How many detergent samples will you test? Add these to the list of materials. Be sure to include a variety of brands and types of detergents — some that wash in cold water, some that include bleach, and so on.

6. What kinds of stains will you test? Add these substances to the list of materials.

7. Write out a procedure for staining the fabric. For example, will you rub in the stains or dab them on? How large will each stain be?

8. How long will you leave the stains on before washing?

9. Detergents will irritate skin, eyes, and lungs. What safety precautions will you follow? To help you decide, research the precautions on each product's web site or MSDS. Write out the safety precautions for this investigation.

10. What control will you use? For example, how will you show that it is the detergent doing the cleaning, and not just the water and agitation?

11. How will you rate each detergent's ability to remove a stain? Write out the criteria for your assessment.
    - You might compare the performances. For example, brand C left more stain visible than brand B.
    - You could rate each detergent's performance against a scale. For example, you might use a scale such as:

      Level 1 — no stain visible

      Level 2 — some discoloration visible on close inspection

      Level 3 — stain clearly visible

      Level 4 — no different than the stain before washing

12. Design a table for recording your observations.

13. Have your group's procedure approved by the teacher, and then carry out the investigation.

14. Clean up any spills and wash your hands thoroughly after doing the activity.

Internet CONNECT

www.mcgrawhill.ca/links/science.connect1

Manufacturers often provide safety information for their products on their web site. Go to the above web site, then to Internet Connects, Unit A, Closer, and on to Laundry Detergent Safety.