Exploring The BUILDING BLOCKS of Science

Book 2

STUDENT TEXTBOOK

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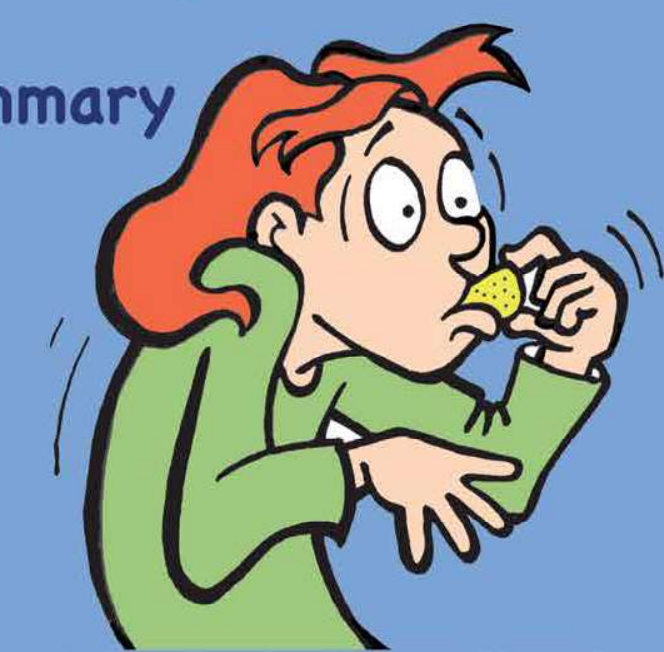
Chapter 3 Acids and Bases



3.1 Introduction

When atoms and molecules meet, they can trade places, join together, or separate from each other. A chemical reaction happens when atoms or molecules meet and any of these changes take place. A chemical reaction is one of the events chemists measure with tools.

In this chapter we will look at some special kinds of chemical reactions. These reactions are called acid-base reactions. Acid-base reactions are easy for chemists to study with some basic tools.

3.2 Acids and Bases Are Different

Have you ever noticed that when you bite a lemon it tastes sour and makes your cheeks pucker?

Have you ever tasted mineral water or baking soda water? They are not sour like a lemon. They are bitter or salty.

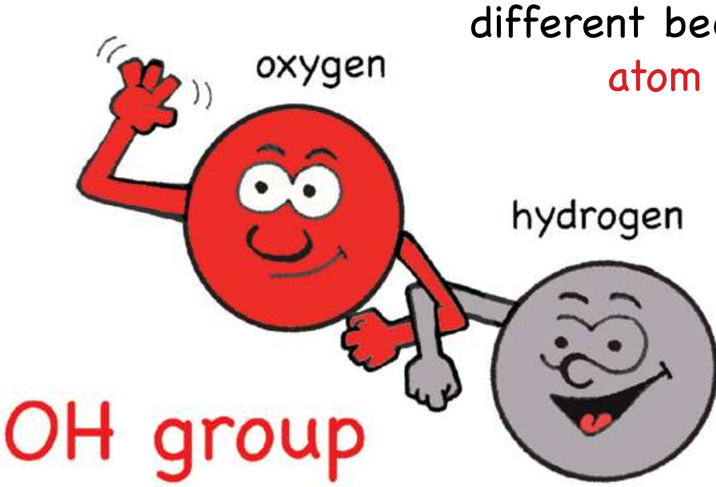
Have you ever noticed that soap is very slippery in your fingers, but lemon juice and vinegar are not?

The molecules inside a lemon are different from the molecules inside baking soda water or mineral water. Lemons have molecules in them called acids. It is the acid in lemons that gives them their sour taste.

Baking soda water and soap contain molecules that are called bases. Bases often make things feel slippery or taste bitter.

3.3 H and OH Groups

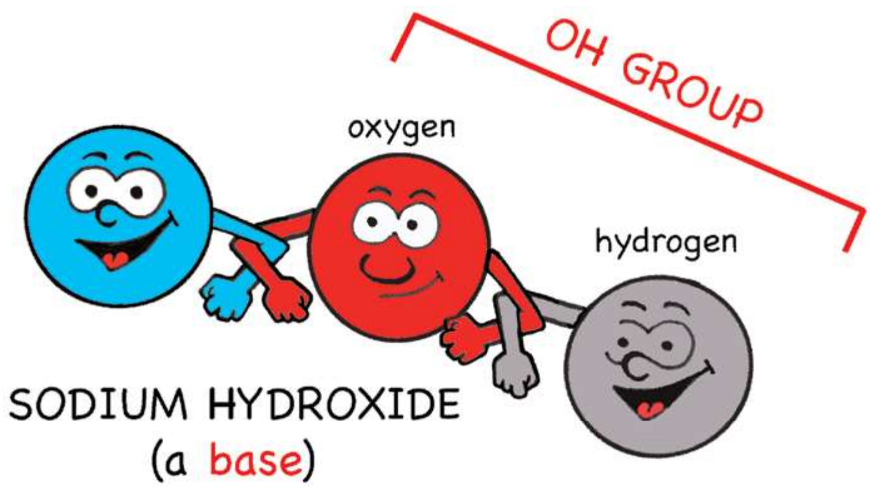
Acids and bases are different from each other in many ways. This is because a base is a different kind of molecule than an acid. Acids and bases are different because they have different atom groups.

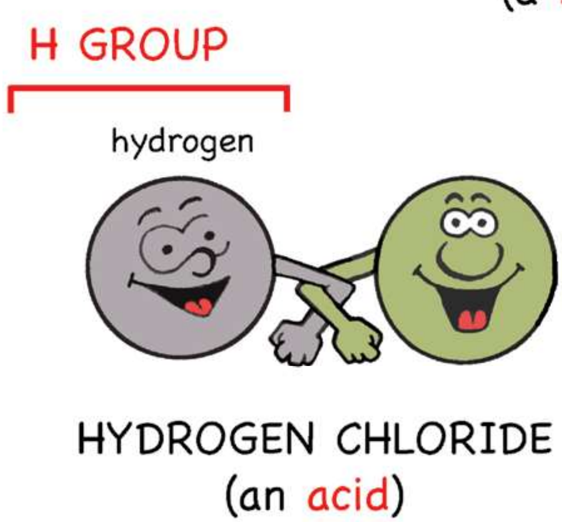


A base has an OH group [say "O" "H" group]. An OH group is just an oxygen atom and a hydrogen atom together.

Most common acids have an H group [say "H" group]. An H group is just a hydrogen atom.

We can see in the next picture that sodium hydroxide (a base) has an OH group and hydrogen chloride (an acid) has an H group.

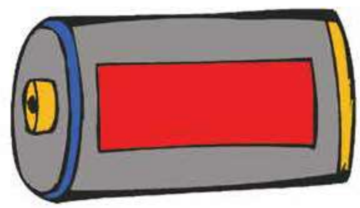


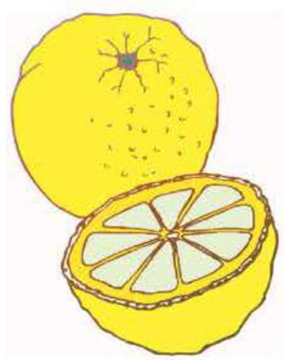


3.4 Both Are Important

Both acids and bases are very important. They are needed in lots of very useful chemical reactions. You have a strong acid inside your stomach to break down your food. Without the acid in our stomachs, we could not digest our food.

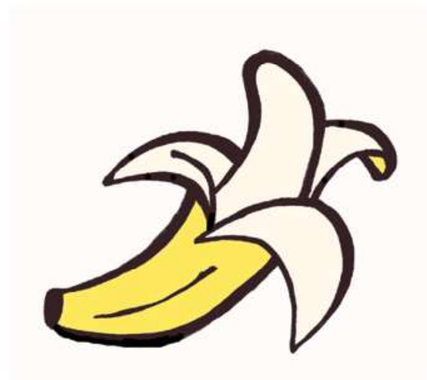
Acids are also found in batteries, lemons, oranges, grapes, and even soda pop.



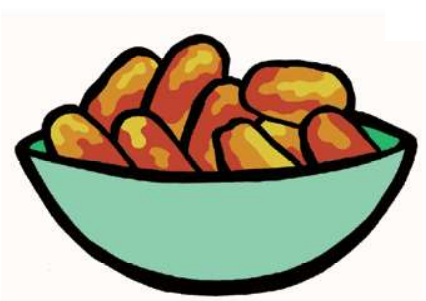


These things have acids in them.

Bases are found in lots of cleaners, like window cleaner, bathroom cleaner, and soap. They are also found in some foods like bananas and dates. Bases are even used to make your stomach feel better! We'll see why in the next chapter.



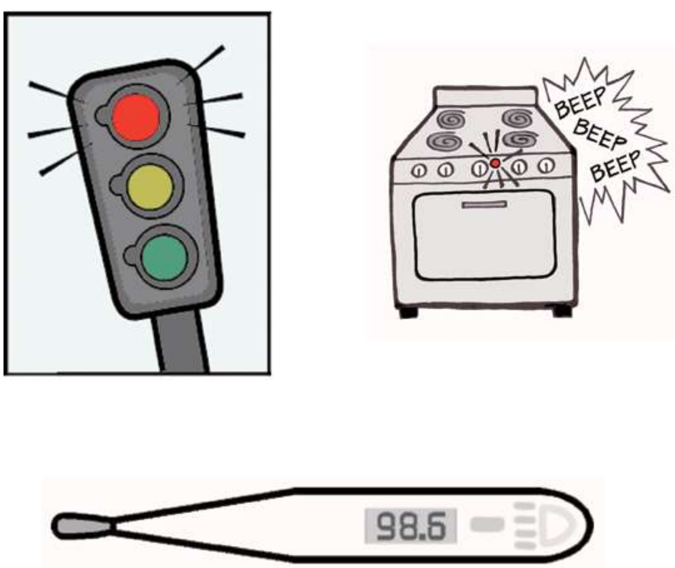
These things
have bases
in them.



3.5 Observing Acids and Bases

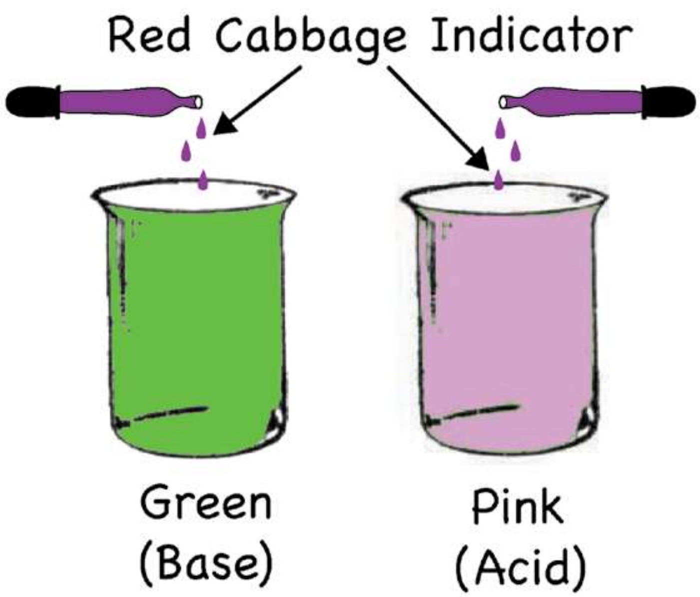
Chemists can use basic tools to see an acid-base reaction. Some acids and bases give off heat or explode when they react. Other times we cannot tell when an acid-base reaction happens. When we can't see an acid-base reaction, we can put something into the acid-base mixture that will show us that the reaction is taking place. This "something" is called an indicator because it indicates, or tells us, something is happening or has happened.

Indicators



We use different kinds of indicators all the time. Stop lights indicate when we can go or when we should stop. When we turn on the oven, an indicator tells us when it is hot enough. A thermometer is an indicator. It can tell when your body has a fever. Indicators are also used in chemistry.

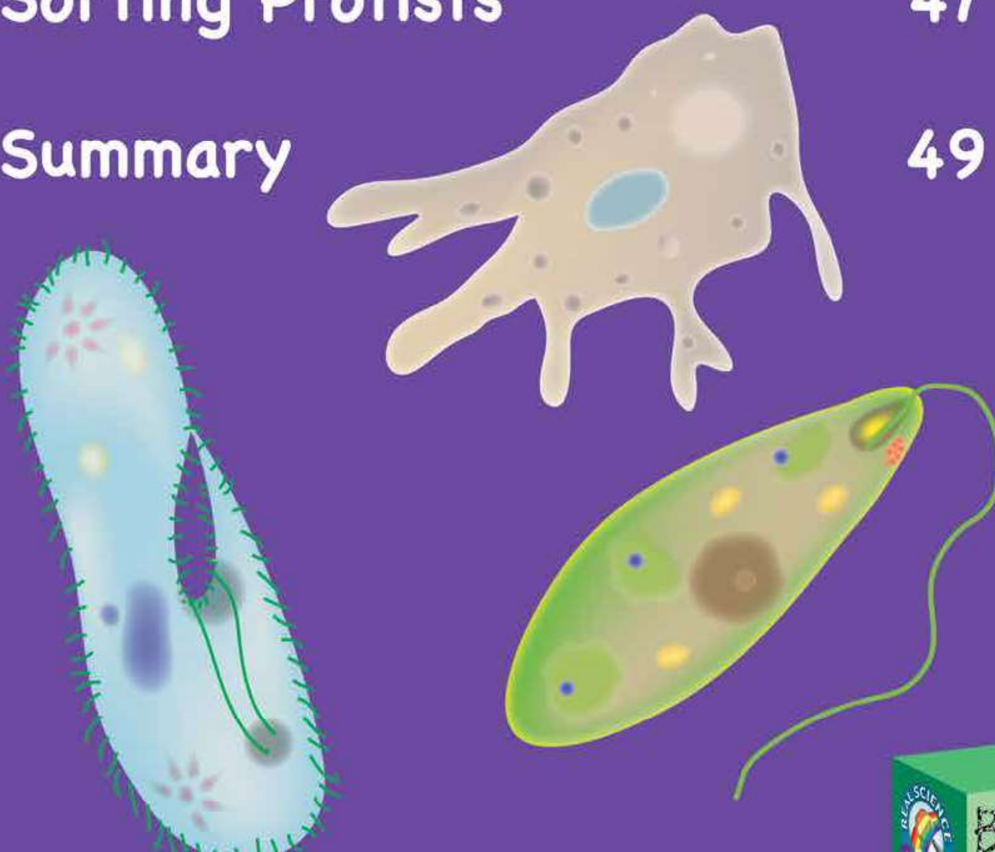
An acid-base indicator tells us whether we have an acid or a base. There are different kinds of acid-base indicators. A simple acid-base indicator is red cabbage juice! Red cabbage juice turns pink with acids and green with bases.



3.6 Summary

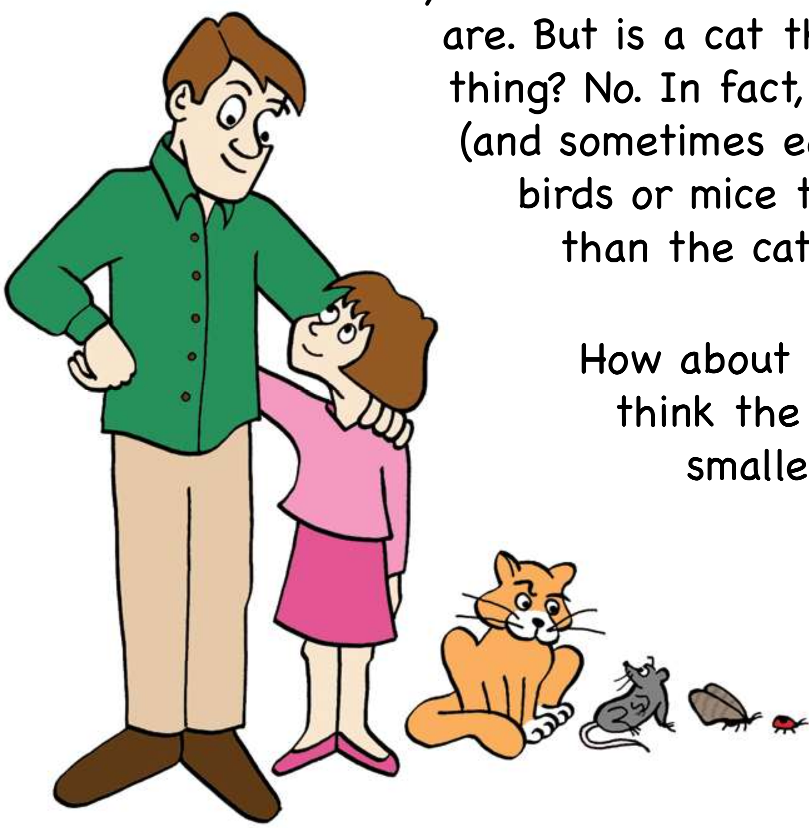
- Acids taste sour.
- Bases taste bitter and are slippery.
- Acids have an H group and bases have an OH group.
- Acids and bases are found everywhere—in batteries, in your stomach, in household cleaners, and even in bananas and lemons!
- An acid-base indicator tells us whether we have an acid or a base.

Chapter 7 Protists Move



7.1 Tiny Creatures

How tiny is the smallest living creature? If you look at yourself, you might think you are pretty small compared to your dad, but are you the smallest living creature? No! You are not as small as your cat. The cat is smaller than you are. But is a cat the smallest living thing? No. In fact, the cat chases (and sometimes eats) moths or birds or mice that are smaller than the cat.



How about a moth? Do you think the moth is the smallest living creature?

No. A ladybug is smaller than a moth, and an ant is smaller than a ladybug, and a gnat is even smaller than an ant. So how small is the smallest living creature?

The smallest living creatures are so small that you can't even see them when looking with just your eyes. There is a whole world of tiny creatures that you can't see that live in ponds, in oceans, in dirt, and even inside of you!

One type of tiny creature you can't see with only your eyes is called a protist (also called a protozoan). A protist is a small creature that can do many of the things bigger creatures (like you) can do. Protists can crawl and swim and eat and sense light. Protists are very small but can do amazing things.

To observe protozoa (protists), you have to use a microscope. The first person to see protists was a man from Holland named Anton van Leeuwenhoek. With his microscope he saw little animals in pond water. He also found them in his mouth!

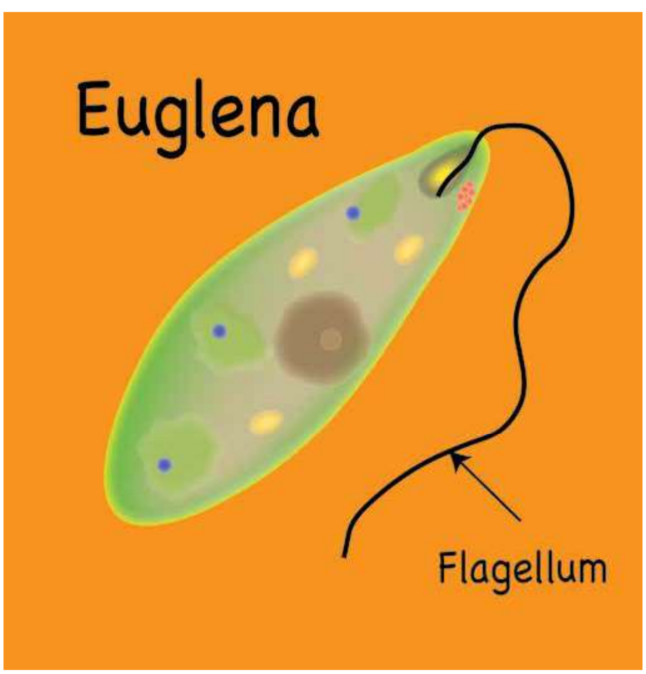
7.2 Different Kinds of Tiny Creatures

There are many different kinds of protists that can be seen only with a microscope. But how do you know what kinds of creatures you are seeing?

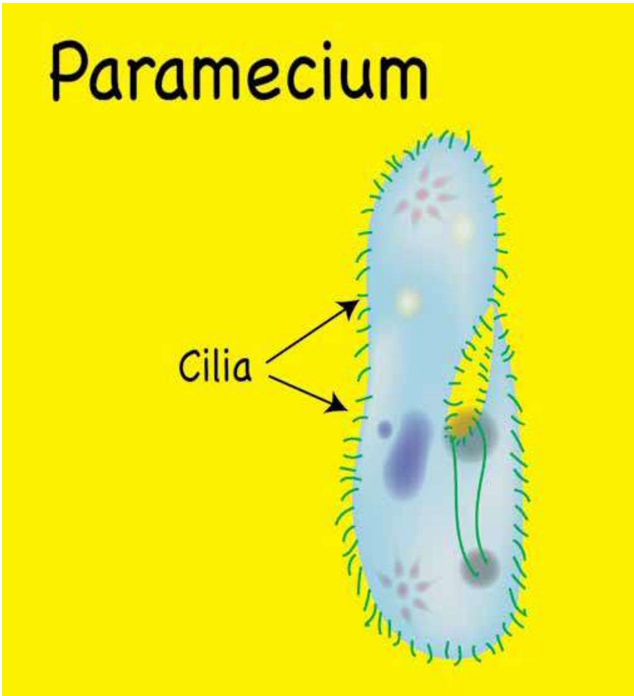
When scientists sort living things into groups, they are easier to study. The kingdom Protista is a very large group with over sixty thousand different kinds of protists. Because it is such a large group, scientists need to sort the protists into even smaller groups.

7.3 Sorting Protists

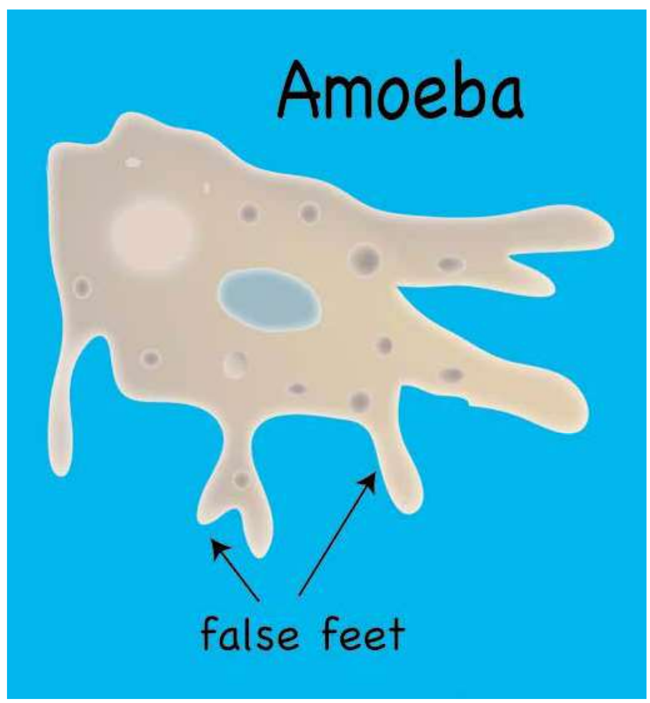
One way to sort protists into smaller groups is to notice the different ways protists move and then group them by how they move.



One way protists move is to swim with a long tail called a flagellum. Some protists, like euglena, have a flagellum. Protists that move by using a flagellum are called Flagellates.



Another way protists move is by using small hair-like features called cilia. Cilia beat fast in the water, making the protists move forwards and backwards and sideways. A paramecium uses cilia to move. Protozoa that move with cilia are called Ciliates.



Some protists move by crawling. Amoebas are protists that use false feet called pseudopods to crawl from one place to another. Protists that use false feet to move are called Amoeboids.

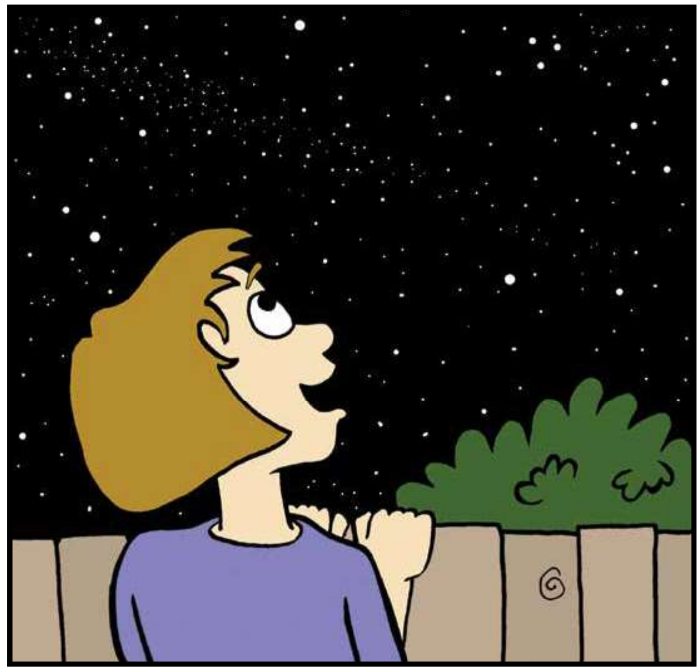
7.4 Summary

- There are many small creatures that we cannot see by using just our eyes.
- Scientists use a microscope to see small creatures.
- Protists (also called protozoa) are small creatures that can be found in pond water and ocean water.
- One way scientists sort protists is by how they move. Three groups of protists are Flagellates, Ciliates, and Amoeboids.
- Many protists move by using a flagellum, by using cilia, or by using pseudopods (false feet) to crawl.

Chapter 19 Observing the Constellations

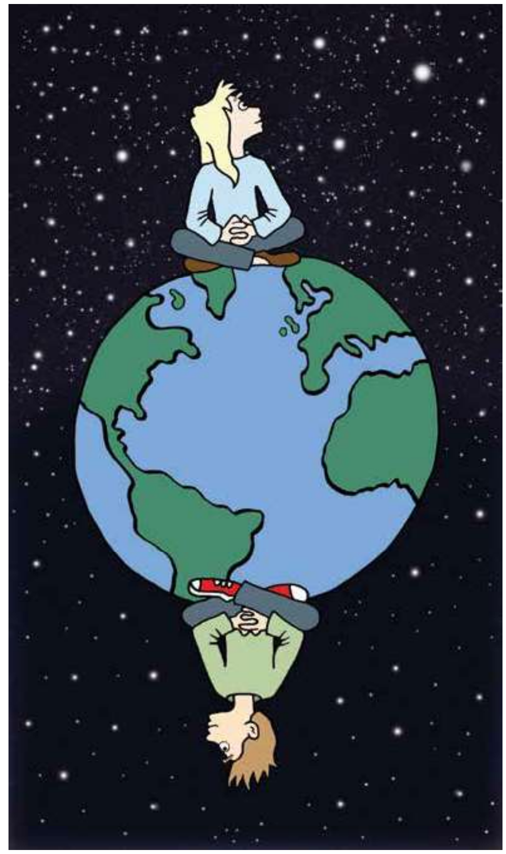
19.1 Introduction

No matter where you are on Earth, if you look up to the sky on a clear, dark night, you can see stars. If you are far away from city lights, it looks like the sky is filled with thousands and thousands of stars. There are so many stars that it is difficult to know the name of each star in the sky.



Even without using a telescope, modern satellites, or space probes, we can learn something about the cosmos by observing stars that form constellations. A constellation is a group of stars that together appear to form a shape or image in the sky. By grouping stars into constellations, a lot can be learned about the sky without knowing all the individual stars.

Some common constellations easily observed in the Northern Hemisphere include the Big Dipper and Cassiopeia. Favorite Southern Hemisphere constellations include the Archer and the Whale.



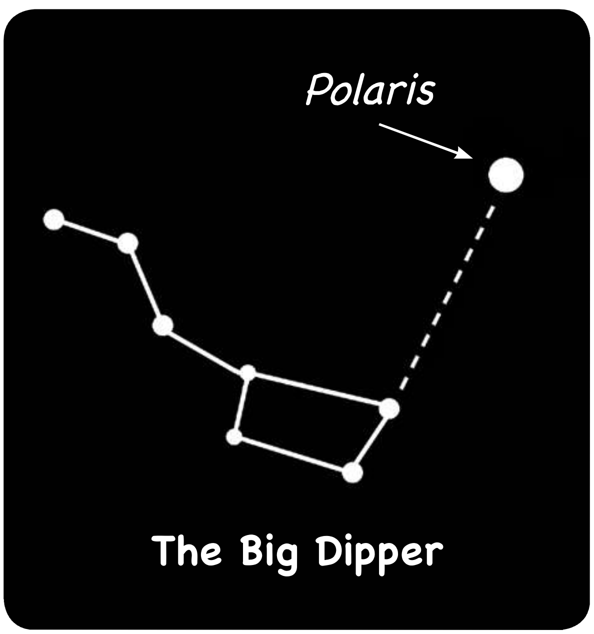
Since Earth is a large sphere, the stars someone can see at the North Pole are different from the stars someone can see at the South Pole. If you are at the equator, over the course of a year you can see all the constellations, but the stars at the North and South Poles will be harder to see.

The constellations change their positions in the sky throughout the night and during the different seasons. This repositioning of the stars is caused by the Earth changing its position in space as it spins on its axis and revolves around the Sun. As the Earth moves, we see the constellations from different angles.

By observing the positions of the constellations in the sky, you can watch the seasons come and go, tell what time of night it is, and determine which direction you are going when traveling on land, sea, or in the air. Knowing the constellations could even help you find your way home if you were taking a trip in outer space!

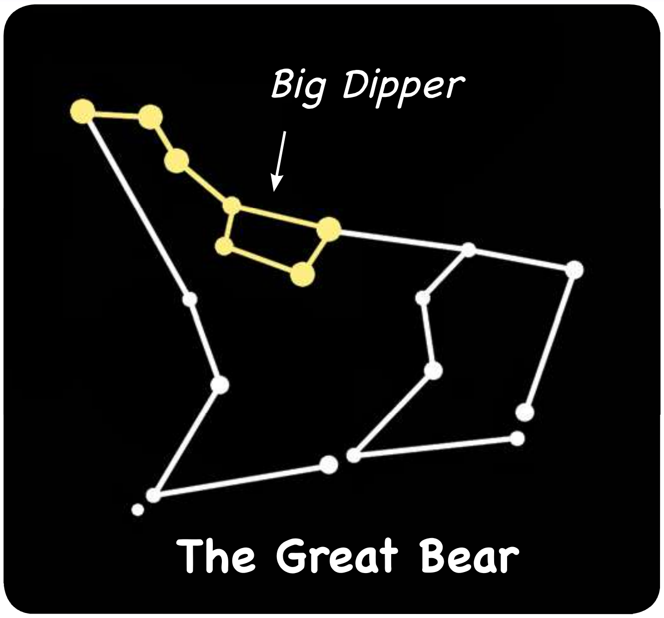
19.2 Northern Hemisphere Constellations

If you live in the Northern Hemisphere there are many constellations you can easily find. A favorite group of stars in the northern sky is called the Big Dipper because its shape looks like a dipper, or ladle. The Big Dipper has 7 stars, three of which form the "handle" and four that form the "bowl" of the dipper. The best time to see The Big Dipper is from February through June.



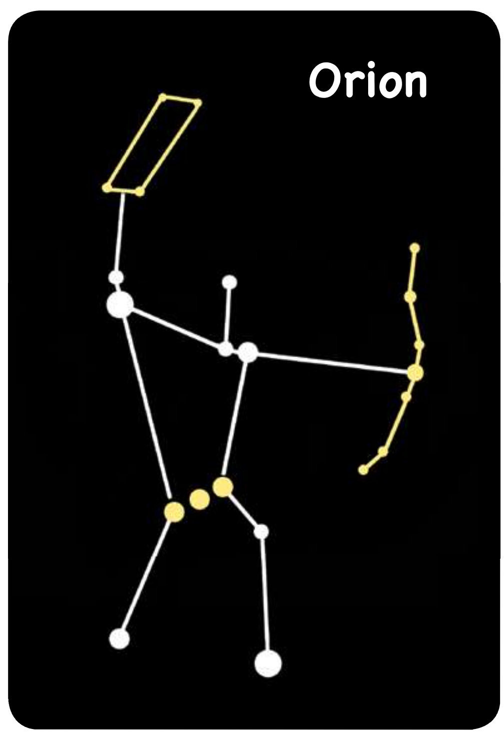
The Big Dipper can be used to locate the star Polaris, which is also called the North Star. Polaris can be found by imagining a line going between the two stars located at the end of the bowl of the Big Dipper and extending the line to a lone star that has no other stars nearby. This star is Polaris.

Polaris is above the northernmost point of the Earth. Because it is near enough to true north, it can be used as a navigational marker. If you were on a boat sailing from Maine to England on a clear night, you could use Polaris to keep your boat on track.



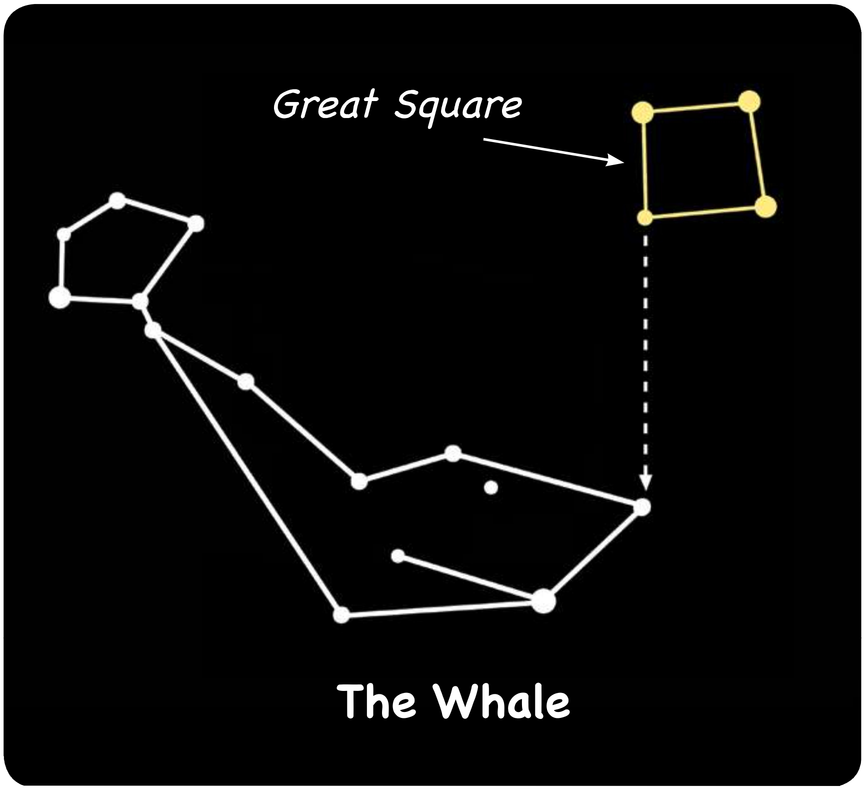
Another interesting constellation to find in the Northern Hemisphere is the Great Bear. The Great Bear includes the Big Dipper. To locate the Great Bear, first find the Big Dipper, and while keeping the Big Dipper in view, expand your gaze to include the three pairs of stars that form the Bear's paws. Once you have these stars and the Big Dipper in view, you can see the rest of the stars that make up the Great Bear. The best time to see the Great Bear is from February through June.

Another favorite constellation is Orion the Hunter. The stars that make up Orion are bright and beautiful which makes it easy to pick out this constellation. A good way to find Orion is to find his belt. Orion's belt is made of three bright stars close together in a straight row. From there you can pick out the shield and raised club. The best time to see Orion is December through March.

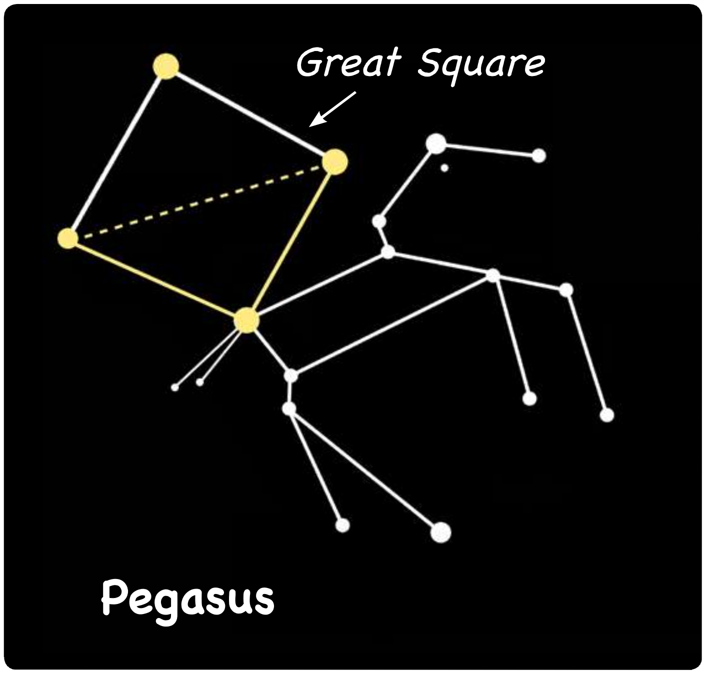


19.3 Southern Hemisphere Constellations

If you live in the Southern Hemisphere, there are lots of fun constellations you can find. One of the largest southern constellations is the Whale. The stars that make up the Whale are dim, but because there are fewer stars to observe in this section of the sky, the Whale can be easily seen on a dark night when there is no Moon or city lights.



To find the Whale, first locate the Great Square. As the name suggests, the Great Square is a set of four bright stars that form a square. Once you locate The Great Square, the Whale is easy to spot. Just follow the line made by the two stars on the side of the Great Square until you see a cluster of 4 to 5 stars. These are the stars that make up the head of the Whale. The best time to see the Whale is October through January.

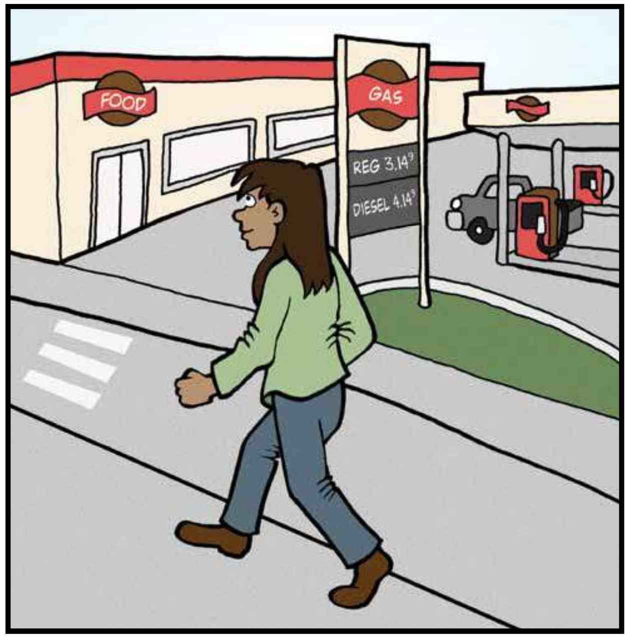


Another favorite constellation in the Southern Hemisphere is Pegasus, the winged horse. Part of the Pegasus constellation includes three of the four stars of the Great Square. These three stars make up the wing of Pegasus which sits on the hind end of the horse. Two little stars near the hind end make up the tail and the head extends in the opposite direction from the tail. The best time of the year to see Pegasus is from August to October.

19.4 Using Stars to Navigate

How do you find your way to the grocery store? How do you know which street to take to the park? If you need to go to a friend's house, do you turn to your right, left, or go straight ahead from your front door?

In each of these situations, you are navigating your way from one place to another place. Navigation simply means to make one's way from one location to another. There are several different techniques people use to navigate.



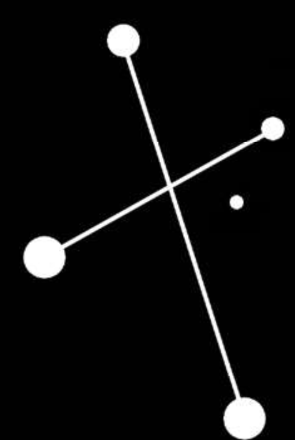
One way to navigate is to use landmarks. If you walk to the grocery store with your parents, you might notice that it is located just across from a park and next to a gas station. The next time you need to go to the grocery store, you can use your knowledge of the park and the gas station as landmarks to guide you to the store. However, if you were far out to sea where there are no landmarks, how would you find your way home?

This was a problem for early sailors. When traveling along the coast, they could use landmarks to find their way, but what happened when they traveled far enough out in the ocean that they could no longer see the shore? Early sailors discovered that they could use the stars as a way to navigate across the sea. Using the stars is

a great way to find your way, whether you are on land, sea, in an airplane or even in space!

One easy star to use for navigation in the Northern Hemisphere is Polaris. Unlike other stars, Polaris actually stays in the same place in the sky and doesn't appear to move. The north pole of Earth's axis points almost directly at Polaris. If you can find Polaris, you can tell which way is north, and once you locate north, you can find south, east, and west.

In the Southern Hemisphere people use the Southern Cross constellation for navigation. Although Earth's axis at the South Pole doesn't point directly at an individual star, the two stars that form the long part of the constellation can be used to find south.



Southern Cross

19.5 Summary

- A constellation is a group of stars that together form a particular shape.
- Common constellations in the Northern Hemisphere include the Big Dipper, the Great Bear, and Orion.
- Common constellations in the Southern Hemisphere include the Whale and Pegasus, both of which can be located by finding the Great Square.
- Stars can be used to navigate, or find the way, from one location to another.

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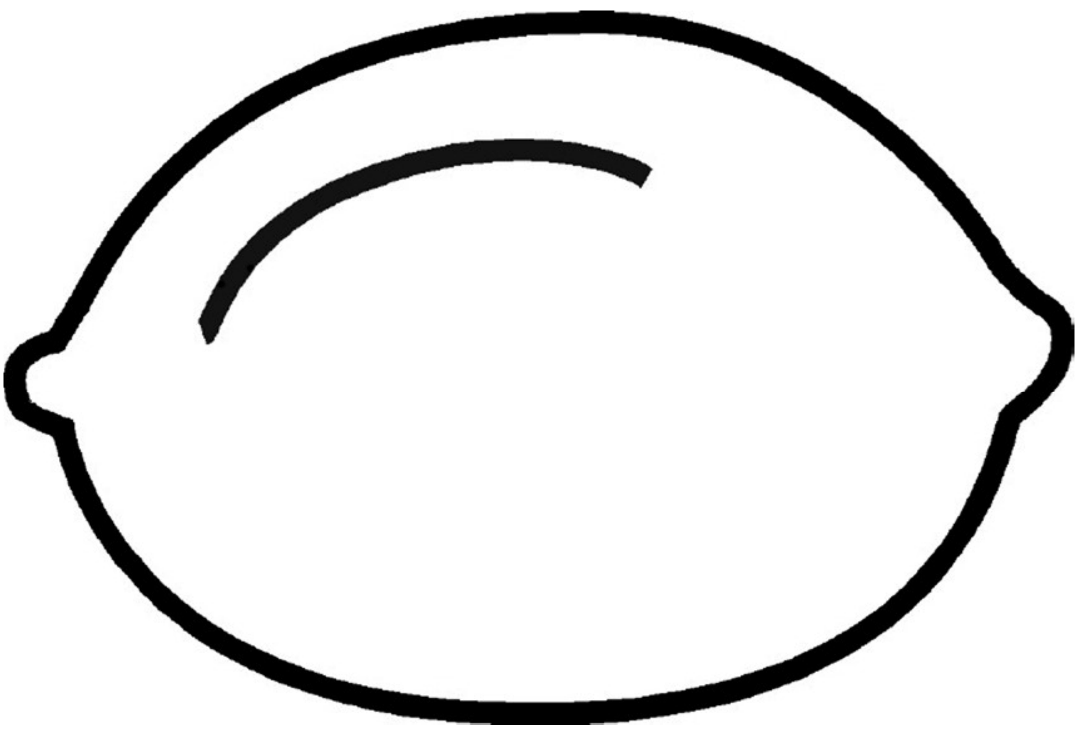
Contents

Experiment 3

Sour or Not Sour?



CHEMISTRY

I. Think About It

Think about each of the liquids listed in the chart below and whether it would taste "sour" or "not sour." Use a check mark to record your answer.

Liquid	Sour	Not Sour
white grape juice		
milk		
lemon juice		
grapefruit juice		
mineral water		
antacid		
distilled water		
baking soda water		

II. Observe It

❶ Tear out the following pages labeled "SOUR" and "NOT SOUR," and place them on a table. Next, taste the liquids and record which are sour and which are not sour. After you test each liquid, place the cup on the paper that has the label that matches the taste.

Liquid	Sour	Not Sour
white grape juice		
milk		
lemon juice		
grapefruit juice		
mineral water		
antacid		
distilled water		
baking soda water		

SOUR

CHEMISTRY

NOT SOUR

(sweet or salty)

❷ Next, pour 60 milliliters (1/4 cup) of red cabbage juice into a plastic cup that contains a liquid you tasted.

❸ Observe what happens. Does the red cabbage juice change color? Record your observations below.

❹ Repeat Steps ❷-❸ for each of the liquids you tasted.

Liquid	**Color change?** (yes or no)	**What is the color?**
white grape juice		
milk		
lemon juice		
grapefruit juice		
mineral water		
antacid		
distilled water		
baking soda water		

CHEMISTRY

III. What Did You Discover?

❶ Which liquids were sour?

❷ Which liquids were not sour?

❸ When you added the cabbage juice to the "sour" liquids, what color did the cabbage juice become?

❹ When you added the cabbage juice to the "not sour" liquids, what color did the cabbage juice become?

❺ Why do you think the "sour" liquids and "not sour" liquids turned the cabbage juice different colors?

❻ If you added cabbage juice to a drink and it turned pink, do you think that drink would taste sour?

IV. Why?

You may have observed that the liquids that were very sour, or even a little bit sour, turned the cabbage juice pink when it was added. You may also have noticed that the liquids that were not sour, and maybe tasted bitter or salty, turned the cabbage juice green when it was added. You may have noticed that milk and water didn't change the color of the cabbage juice, but instead the cabbage juice turned the milk and water purple. Do you know why?

The red cabbage juice is called an *indicator*. In chemistry an indicator is something that tests a substance. In this case, the red cabbage juice is an indicator that tests whether a liquid is an acid or a base. The sour liquids are acids, and the bitter or salty liquids are bases. Milk and water don't change the color of the red cabbage juice indicator at all, so they are neither acids nor bases. They are called neutral.

An acid will always change the color of the red cabbage juice indicator to pink, and a base will always change the color of the red cabbage juice indicator to green. A neutral liquid, like milk or water, will never change the color of the red cabbage juice indicator.

This is why the liquids turned pink, green, or purple when the red cabbage juice was added!

CHEMISTRY

V. Just For Fun

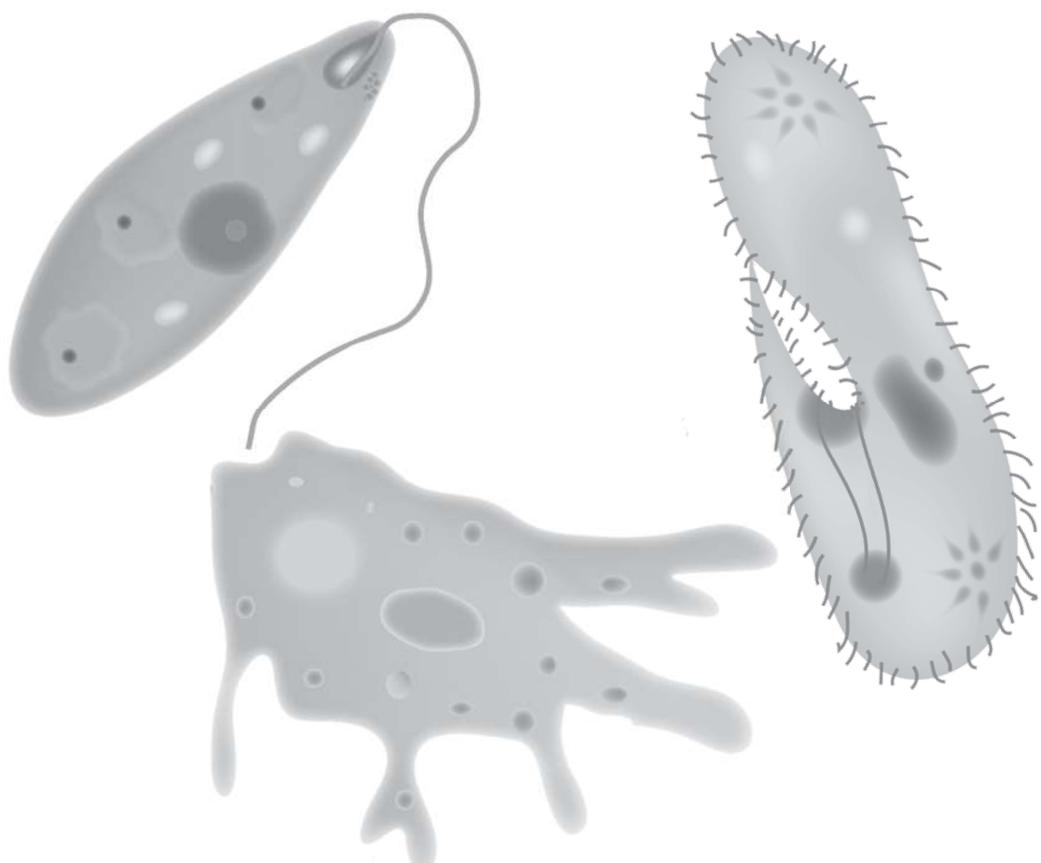
Look around for some other liquids you can test with the red cabbage juice indicator. Observe whether the cabbage juice changes color when added to the liquids.

Do not taste these liquids, but decide if each is an acid, a base, or neutral according to the color change. Record your observations.

LIQUID	ACID, BASE, OR NEUTRAL

Experiment 7

Little Creatures Move



Introduction

In this experiment you will take a look at some tiny creatures that are too small to see when you use only your eyes.

I. Think About It

If you look at some pond water with a microscope, what do you think you will see? Draw what you think you will see.

II. Observe It

❶ Take some pond water and put it under the microscope. Draw what you see.

❷ See if you can observe moving creatures that are different from each other. Draw one here.

❸ Draw a different moving creature here.

BIOLOGY

❹ Draw a different moving creature here. Note if it moves differently.

❺ Draw a different moving creature here. Note if it moves differently.

❻ Are there two creatures that are similar? Draw them here.

❼ Are there two creatures that are different? Draw them here.

III. What Did You Discover?

❶ Did the pond water look like you thought it would? Why or why not?

___

___

❷ What was the first thing you noticed about the pond water?

___

___

❸ Was there anything you did not expect to find in the pond water? Describe it.

___

___

❹ How many different creatures did you find?

___

___

❺ Did you find two or more that moved in different ways?

___

___

❻ Describe your favorite creature. Explain why it is your favorite.

___

___

___

IV. Why?

Pond water is full of little creatures. In fact, little creatures are found in soil, in hay, and in oceans and rivers. You might also find unwanted creatures on your toothbrush! Many of these little creatures are called protists (also called protozoa).

There are many different kinds of protists. Many types of protists move by using a large whip-like tail called a flagellum. Other types of protists use small hairs called cilia to move. And still other types of protists crawl using "false feet."

Using a microscope, you can observe protists move. You might see them move forward and backward. You might see them bump into a piece of food or even bump into each other. You can see them roll and stop and turn and then start moving again.

Protists need to move to find food or escape from danger or find a place to rest, just like you do. Humans have legs to move. If your mom calls you for dinner, you need to get up from reading this book and walk to the table to eat. If you are strolling in the park and a big dog starts barking, you might want to run away as fast as your legs will move. When it gets dark and you are ready for bed, you walk to your room (after using your new protist-free toothbrush on your teeth) to go to sleep. You are designed differently from a protist, but protists can also use their bodies to move just like you do!

V. Just For Fun

Leeuwenhoek looked at organisms in his mouth. What's in your mouth?

Spit onto a slide and see if you can observe any moving things in your saliva. Draw anything you discover.

What's In Your Mouth?

Experiment 19

Tracking a Constellation

Introduction

Do you think the stars are always in the same position when you look at the sky? Make some observations to find out.

I. Think About It

❶ How many constellations do you think you could find in the night sky?

____

❷ Do you think they would change position over the course of a single night? Why or why not?

____

____

____

❸ If you were standing on the North Pole could you see the constellations in the Southern Hemisphere? Why or why not?

____

____

____

❹ If you were standing on the South Pole could you see the Northern Hemisphere constellations? Why or why not?

____

____

____

II. Observe It

1. Pick your favorite constellation to observe for one week.
2. On the first night of the experiment, go outside and look for your constellation. If you don't see it the first time out, you can go outside for several nights in a row until you find it.
3. Note the time, day, and month you first see your constellation.

Constellation ______________________

Time ______________________

Day ______________________

Month ______________________

4. Once you find your constellation, record where in the sky you found it. Was it directly above you? Lower in the sky? Towards the east or west?

Position of the Constellation

❺ Follow your constellation by observing it at the same time every day for six more days. Note if it changes location. Record your observations in the following boxes.

Observations **Date** ______________

Observations **Date** ______________

Observations **Date** ______________

Observations **Date** ________________

Observations **Date** ________________

Observations **Date** ________________

Notes ____

____

III. What Did You Discover?

❶ What is the name of your favorite constellation?

❷ What was the day, time, and month that you first observed your favorite constellation?

❸ What was the season? (summer, spring, fall, or winter?)

❹ How easy or difficult was it to find your constellation? Why?

❺ How easy or difficult was it to follow your constellation for a week? Why?

❻ During that week, did your constellation move?

IV. Why?

Seasonal Movement of Constellations

In this experiment you observed your favorite constellation at the same time each night. You might have discovered that the constellation's position in the sky changed from one night to the next. This occurs because as the Earth orbits the Sun, Earth's position relative to the constellations changes. Each night you are seeing the constellations from a slightly different location in space. The night sky changes during the course of the year as Earth orbits the Sun and changes its position in space.

Try this experiment. Wait a month. Then go outside at the same time you did when viewing the constellation for a week. Look for the constellation. How much has it moved?

Nightly Movement of Constellations

With the exception of Polaris, the North Star, all of the stars and constellations appear to move in the sky during the course of a single night. This is due to Earth's rotation on its axis. As the place where you are located moves around Earth's axis during the night, you see the constellations from different angles. This makes it appear that the constellations are moving through the sky, but actually you are moving. This is similar to the way the Sun appears to move around the Earth. It is really the Earth moving around its axis that causes the Sun's change of position above a particular location on Earth's surface.

V. Just For Fun

Constellations go back to ancient times when people looked at the night sky and noticed groups of stars that reminded them of the shapes of people, animals, and other objects.

For this experiment look at clouds in the sky in the daytime. What do their shapes look like? You may want to lie on your back in the grass while performing this experiment. If there aren't any clouds around, look for a textured surface (like a wall or rock cliff) and see what shapes you can find there.

Once you've found a shape that interests you, draw a picture of it and write a short story about it.

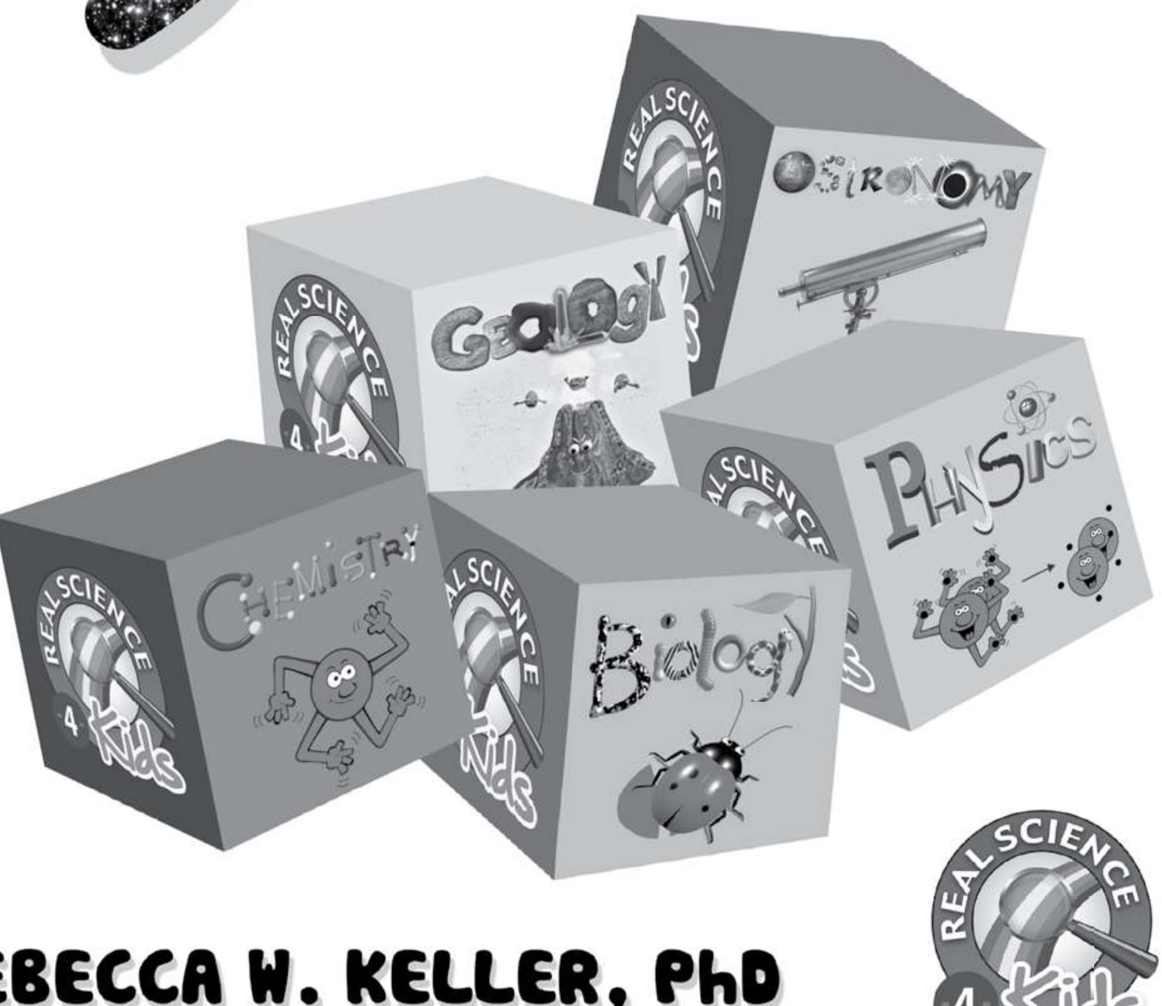
What I See — The Drawing

What I See — The Story

Exploring The BUILDING BLOCKS of Science

Book 2

TEACHER'S MANUAL



REBECCA W. KELLER, PhD

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A Note From the Author

This curriculum is designed for elementary level students and provides an introduction to the scientific disciplines of chemistry, biology, physics, geology, and astronomy. *Exploring the Building Blocks of Science Book 2 Laboratory Notebook* accompanies the *Building Blocks of Science Book 2 Student Textbook*. Together, both provide students with basic science concepts needed for developing a solid framework for real science investigation. The *Laboratory Notebook* contains 44 experiments—two experiments for each chapter of the Student Textbook. These experiments allow students to further explore concepts presented in the *Student Textbook*. This teacher's manual will help you guide students through laboratory experiments designed to help students develop the skills needed for the first step in the scientific method — making good observations.

There are several sections in each chapter of the *Laboratory Notebook*. The section called *Think About It* provides questions to help students develop critical thinking skills and spark their imagination. The *Observe It* section helps students explore how to make good observations. In every chapter there is a *What Did You Discover?* section that gives the students an opportunity to summarize the observations they have made. A section called *Why?* provides a short explanation of what students may or may not have observed. And finally, in each chapter an additional experiment is presented in *Just For Fun*.

The experiments take up to 1 hour. The materials needed for each experiment are listed on the following pages and also at the beginning of each experiment.

Enjoy!

Rebecca W. Keller, PhD

Materials at a Glance

Experiment 1	Experiment 3	Experiment 4	Experiment 5	Experiment 6
magnifying glass butterfly or bug's wing (or substitute a leaf, flower, piece of wood, or rock) colored pencils microscope (or additional object to observe with a magnifying glass) **Experiment 2** salt, 15 ml (1 Tbsp.) water, 237 ml (1 cup) brick of modeling clay, 1 or 2 sugar	12 (or more) clear plastic cups measuring cup measuring spoons marking pen one head of red cabbage knife cooking pot, large food items: • distilled water, 1.25-1.75 liters (5-7 c.) • white grape juice, 60 ml (¼ cup) • milk, 60 ml (¼ cup) • lemon juice, 60 ml (¼ cup) • grapefruit juice, 60 ml (¼ cup) • mineral water, 60 ml (¼ cup) antacid tablets—3 extra-strength unflavored white Tums baking soda, 5 ml (1 tsp.) other substances (see *Just For Fun* section) **Optional** small plastic bag wooden mallet or other hard object for crushing antacids	18 or more clear plastic cups measuring cup measuring spoons marking pen leftover red cabbage juice from Experiment 3 or one head of red cabbage food items, approx 300 ml (1¼ c) each: • vinegar • lemon juice • mineral water • distilled water (if you need to make red cabbage juice, you will need 1.5 liters more) baking soda, 25 ml (5 tsp.) or more antacid tablets, 5 or more (try Tums plain, white, extra strength) substances of students' choice to mix together	the following food items: • marshmallows (2-3) • ripe banana • green banana • pretzels or salty crackers, several • raw potato • cooked potato • other food items blindfold	magnifying glass colored pencils

Experiment 7	Experiment 8	Experiment 9	Experiment 10	Experiment 11
microscope with a 10x or 20x objective lens (look online for sources such as Carolina Biological Supply)[1] plastic microscope slides eye dropper pond water or protozoa kit[1] Protists (protozoa) can also be observed in hay water. To make hay water, cover a clump of dry hay with water and let it stand for several days at room temperature. Add water as needed.	(see Experiment 7) small piece of chocolate **Optional** baker's yeast Eosin Y stain[2] distilled water	6-8 sealable plastic bags waterproof disposable gloves piece of newspaper or plastic 2 pieces of fruit 2-3 pieces of bread (works best if bread does not have preservatives) marking pen water **Optional** colored pencils	clock or stopwatch	1 small glass marble 1 large glass marble

[1] As of this writing, the following materials are available from Home Science Tools, www.hometrainingtools.com: plastic microscope slides, MS-SLIDSPL or MS-SLPL144, Basic Protozoa Set, LD-PROBASC

[2] Eosin Y stain, CH-EOSIN

Experiment 12	Experiment 13	Experiment 14	Experiment 15	Experiment 16
stopwatch or clock an area to run in items for marking the beginning and ending of the running distance	4 plastic or Styrofoam cups with the mouth larger than the base 2 long poles (dowels work well or any two long sticks that are the same thickness from end to end) tape a cylinder, 10-13 cm long (4-5 inches) [such as a pencil, a dowel, a cylindrical block, or a cylindrical drinking glass that is not tapered; a paper towel tube may be used if it is filled with sand and the ends taped] chalk	plastic hammer regular metal hammer 3 pieces of banana 3 hardboiled eggs in the shell 3 raw potato halves 3 rocks of the same type and size (students can collect these) safety glasses **Optional** 8 pieces of paper marking pen	a toy, small music box, or toy car that can be taken apart a second similar item that can be taken apart screwdriver small hammer other tools as needed **Note:** The objects used in this experiment may not work again.	2 clear, tall glasses (drinking or parfait glasses) spoon (1 or more) 3-6 student-chosen food items for building a parfait model of Earth's layers (such as: graham crackers, peanut brittle, cookies, hot fudge, Jell-O, pudding, ice cream, cream cheese, cherry, nut, jelly bean. etc.) student-chosen inedible items that can be used to build a parfait model of Earth's layers (such as: rocks, mud, dirt, clay, dog or cat food, Legos, etc.) colored pencils

Experiment 17	Experiment 18	Experiment 19	Experiment 21	Experiment 22
colored pencils outdoor thermometer helium-filled balloon string	colored pencils clear night sky basketball or other large object(s) **Telescope materials*** empty cardboard paper towel tube 1-2 sheets of card stock or 1 manila file folder cut in half tape 2 lenses with different focal lengths from Home Science Tools: Item# OP-LEN4x15 and Item# OP-LEN4x50 http://www.hometrainingtools.com * Alternatively, you can look online for a telescope kit	colored pencils night sky daytime sky or textured surface **Optional** book or online information about constellations globe or basketball **Experiment 20** Styrofoam ball pick, awl, or other thin, sharp object to poke a hole through the center of the ball nylon string scissors 2 or more marbles of different sizes cups that are different sizes	flashlight with new batteries glow sticks in assorted colors may be found in places such as Walmart, toy stores, and online	10 small pieces of paper box for the paper pieces 2 beakers or jars: • one with 118 ml (½ cup) of vinegar • one with 118 ml (½ cup) of baking soda and water (5 ml [1 tsp] baking soda in 118 ml (½ cup) water) magnifying glass 2 balls of different weights (e.g., a glass marble and a metal marble, a plastic ball and a baseball) rock hammer or regular metal hammer safety glasses, 1 pair garden trowel or large metal spoon 10 pieces of paper 5 pens or pencils 4 friends or family members to help with the experiment scissors

Materials

Quantities Needed for All Experiments

Equipment	Foods	Foods (continued)
basketball or other large object(s) beakers or jars, 2 blindfold cooking pot, large eye dropper flashlight with new batteries glasses, safety, 1 pair hammer, plastic hammer, regular metal or rock hammer hammer, small knife magnifying glass, 1-2 measuring cup measuring spoons microscope with a 10x or 20x objective lens (look online for sources such as Carolina Biological Supply) microscope slides, plastic [1] pick, awl, or other thin, sharp object to poke a hole through the center of a Styrofoam ball scissors screwdriver spoon (1 or more) stopwatch or clock thermometer, outdoor tools, misc. as needed trowel, garden or large metal spoon **Optional** mallet, wooden, or other hard object for crushing antacid tablets	antacid tablets—8 or more extra-strength unflavored white Tums baking soda, 35 ml (7 tsp.) or more banana, green, 1 banana, ripe, 2 bread, 2-3 pieces (bread without preservatives works best) cabbage, red, 1-2 heads cabbage juice, red, left over from Experiment 3 or one head of red cabbage to make new cabbage juice chocolate, small piece eggs, hardboiled in shell, 3 fruit, 2 pieces grape juice, white, 60 ml (¼ cup) grapefruit juice, 60 ml (¼ cup) lemon juice, 360 ml (1½ cup) marshmallows (2-3) milk, 60 ml (¼ cup) misc. food items misc. student-chosen food items for building a parfait model of Earth's layers (such as: graham crackers, peanut brittle, cookies, hot fudge, Jell-O, pudding, ice cream, cream cheese, cherry, nut, jelly bean. etc.) potato, cooked, 1 potato, raw, 3 pretzels or salty crackers, several salt, 15 ml (1 Tbsp.) sugar vinegar, 415 ml (1¾c) water, distilled, 1.5-3.5 liters (1.5-3.75 qt) or more water, mineral, 360 ml (1½ cup) water, tap	**Optional** baker's yeast

[1] As of this writing, the following materials are available from Home Science Tools, www.hometrainingtools.com: plastic microscope slides, MS-SLIDSPL or MS-SLPL144, Basic Protozoa Set, LD-PROBASC

Materials

Quantities Needed for All Experiments

Materials	Materials (continued)	Other
ball, Styrofoam balls of different weights (2), e.g., a glass marble and a metal marble, a plastic ball and a baseball balloon, helium-filled book or online information about constellations card stock, 1-2 sheets, or 1 manila file folder cut in half chalk clay, modeling, 1-2 bricks colored pencils cups, clear plastic, 30 or more cups, 4 plastic or Styrofoam, with the mouth larger than the base cups, several of different sizes cylinder, 10-13 cm long (4-5 inches) [such as a pencil, a dowel, a cylindrical block, or a cylindrical drinking glass that is not tapered; a paper towel tube may be used if it is filled with sand and the ends taped] glasses, 2 clear, tall drinking or parfait glasses gloves, waterproof disposable gloves, 2 pairs glow sticks in assorted colors—may be found in places such as Walmart, toy stores, and online items for marking the beginning and ending of a running distance items, misc.: student-chosen inedible items to use to build a parfait model of Earth's layers (such as: rocks, mud, dirt, clay, dog or cat food, Legos, etc.)	lenses (2) with different focal lengths Home Science Tools: Item# OP-LEN4x15 and Item# OP-LEN4x50 http://www.hometrainingtools.com (available as of this writing) * Alternatively, you can look online for a telescope kit marble, glass, 1 large marble, glass, 1 small marbles, 2 or more of different sizes newspaper or plastic, 2 pieces paper, 10 small pieces and box to put them in paper, 18 sheets or more paper towel tube, empty pen, marking pencils or pens, 5 pencils, colored plastic bags, sealable, 6-8 poles, 2 long (dowels work well or any two long sticks that are the same thickness from end to end) rocks, 3 of the same type and size (students can collect these) string, any string, nylon substances of students' choice to mix together tape toy, small music box, or toy car that can be taken apart and a second similar item that can be taken apart (they may not work again) **Optional** Eosin Y stain[2] globe (world) or basketball object (additional object to observe with a magnifying glass) plastic bag, small	area to run in butterfly or bug's wing (or substitute a leaf, flower, piece of wood, or rock) friends or family members (4) to help with experiment sky, clear night sky, daytime, or textured surface substances, other (see *Just For Fun* section, Experiment 3) water, pond or hay, or protozoa kit[1] Protists (protozoa) can be observed in hay water. To make hay water, cover a clump of dry hay with water and let it stand for several days at room temperature. Add water as needed.

[2] As of this writing, the following materials are available from Home Science Tools, www.hometrainingtools.com:
Eosin Y stain, CH-EOSIN

Contents

Experiment 3

Sour or Not Sour?

Materials Needed

- 12 (or more) clear plastic cups
- measuring cup
- measuring spoons
- marking pen
- one head of red cabbage
- knife
- cooking pot, large
- the following food items:
  distilled water, 1.25–1.75 liters (5–7 cups)
  white grape juice, 60 ml (1/4 cup)
  milk, 60 ml (1/4 cup)
  lemon juice, 60 ml (1/4 cup)
  grapefruit juice, 60 ml (1/4 cup)
  mineral water, 60 ml (1/4 cup)
  antacid tablets—3 extra-strength unflavored white Tums
  baking soda, 5 ml (1 teaspoon)
- other substances to test (see *Just For Fun* section)

Optional

- small plastic bag
- wooden mallet or other hard object for crushing antacid tablets

Objectives

In this experiment students will begin to explore the properties of acids and bases.

The objectives of this lesson are:

- To have students observe that acids and bases have different properties.
- To introduce the concept of indicators — in this experiment, red cabbage juice is used as an acid-base indicator to determine whether liquids are acids or bases.

Experiment

This experiment requires that students taste both acids and bases. It is relatively easy to find foods that are acidic but much more difficult to find foods that are basic. The only two safe products that we could find that are basic are baking soda and antacids. Most household cleaning products are basic, but these are not listed since they are not safe to taste.

Setup

NOTE: Do not use tap water for this experiment. Use only distilled water or you will not get the correct results.

To do 1 hour before the experiment

Chop or shred the head of red cabbage, and boil it in 1-1.5 liters (4-6 cups) of distilled water for 15 minutes. Remove the cabbage and allow the liquid to cool to room temperature.

Prepare liquids to be tested.

Dissolve the antacid tablets in distilled water. Add three extra-strength unflavored white Tums tablets to 60 milliliters (1/4 cup) of distilled water. Crushing the tablets may help in obtaining the color change of the cabbage juice indicator. To crush them, the tablets can be put in a plastic bag and hit with a hard object, such as a wooden mallet. If this mixture does not change the color, try adding more tablets. Other brands of antacids may or may not work.

To make the baking soda water, add 5 milliliters (1 teaspoon) of baking soda to 60 milliliters (1/4 cup) of distilled water.

Pour 60 milliliters (1/4 cup) of each liquid into a separate clear plastic cup, and using a marking pen, label each cup with the name of its contents.

I. Think About It

Read the text with your students.

Have the students make predictions about which liquids will taste sour and which will not taste sour. Help them mark their predictions in the proper column of the table in their *Laboratory Notebook*. Their answers may vary.

II. Observe It

Read this section of the *Laboratory Notebook* with your students.

❶ Have the students tear out the *Laboratory Notebook* pages that are labeled "SOUR" and "NOT SOUR" and place them on a table.

Have the students taste each liquid and indicate on the chart in the *Laboratory Notebook* whether it is sour or not sour. Help them try to distinguish between "sour" and "bitter." The mineral water and the baking soda water will taste "bad" but not sour. They are bitter or salty. The antacid water will taste sweet. Also, white grape juice may be sweet and not necessarily sour. Let the students decide whether they think it is sour or not sour. After recording each answer, have them place the cup of liquid on either the SOUR or NOT SOUR page, according to the taste.

Their answers may look as follows (answers may vary).

Liquid	Sour	Not Sour
white grape juice		*X*
milk		*X*
lemon juice	*X*	
grapefruit juice	*X*	
mineral water		*X*
antacid		*X*
distilled water		*X*
baking soda water		*X*

❷ Pour into a measuring cup the red cabbage juice that you made earlier and have the students observe the color of the cabbage juice. Then have them select one of the cups of liquid they tasted and observe the color of that liquid. Next, have them add 60 milliliters (1/4 cup) of red cabbage juice to the liquid.

❸ Ask them whether the color changes or stays the same. What they are looking for is ***the color change of the cabbage juice***. Its natural color is a deep red-purple. It will change to pink, green, or light purple when mixed with the other liquids.

Have the students return the cup to the SOUR or NOT SOUR page they took it from, and have them record their results.

CHEMISTRY

❹ Have the students repeat Steps ❷-❸ for each of the liquids they tasted. Expected results are shown in the following chart:

Liquid	Color change? (yes or no)	What is the color?
white grape juice	*yes*	*pink*
milk	*no*	*purple*
lemon juice	*yes*	*pink*
grapefruit juice	*yes*	*pink*
mineral water	*yes/no*	*light purple*
antacid	*yes*	*green*
distilled water	*no*	*purple*
baking soda water	*yes*	*green*

III. What Did You Discover?

Have the students look at the cups that are on the SOUR and NOT SOUR pages. Ask them to observe the colors of the liquids and whether they see similarities or differences between those that are on the same page.

Help the students answer the questions in this section. Example answers follow.

(Answers may vary.)

❶ Which liquids were sour? *lemon juice and grapefruit juice*

❷ Which liquids were not sour? *milk, distilled water, mineral water*

❸ When you added the cabbage juice to the "sour" liquids, what color did the cabbage juice become? *pink*

❹ When you added the cabbage juice to the "not sour" liquids, what color did the cabbage juice become? *green or purple*

❺ Why do you think the "sour" liquids and "not sour" liquids turned the cabbage juice different colors? *They have different types of molecules.*

❻ If you added cabbage juice to a drink and it turned pink, do you think that drink would taste sour? *yes*

IV. Why?

Read the text with your students.

Discuss this section with the students. Have them think about why some of the liquids turned the red cabbage juice pink and some turned it green. Explain to them that the liquids that turned the cabbage juice pink are called acids, and the liquids that turned the cabbage juice green are called bases.

Explain that red cabbage juice is an indicator, which is anything that points out something to us. For example, a gas gauge in a car could be called an indicator—it tells the level of gas in the tank. The thermostat in a house could be called an indicator—it tells the temperature of the room.

In chemistry the term *indicator* refers to a chemical that tells you something about other chemicals. Red cabbage juice is an acid-base indicator, telling you whether the liquid is acidic or basic.

Explain that red cabbage juice will always turn pink in acids and will always turn green in bases unless there is something wrong with the indicator. Some liquids, such as milk and water, do not turn the indicator another color. Explain that these liquids are called *neutral*, and they are neither acids nor bases.

V. Just For Fun

Help the students find some other liquids to test with the red cabbage juice indicator. The students are **NOT TO TASTE** these liquids, so they can select some things like household cleaners that are not edible. They can also mix a powdered substance into distilled water and test the mixture.

Have the students decide whether the liquid is an acid, a base, or neutral, and help them record their observations.

Experiment 7

Little Creatures Move

Materials Needed

- microscope with a 10x or 20x objective lens (look online for sources such as Carolina Biological Supply)
- plastic microscope slides
- eye dropper
- pond water or protozoa kit

Protists (protozoa) can also be observed in hay water. To make hay water, cover a clump of dry hay with water and let it stand for several days at room temperature. Add water as needed.

As of this writing, the following materials are available from Home Science Tools, www.hometrainingtools.com:

- plastic microscope slides, MS-SLIDSPL or MS-SLPL144
- Basic Protozoa Set, LD-PROBASC

Objectives

In this unit students will look at pond water, hay water, or a protozoa kit to observe how protists (protozoa) move.

The objectives of this lesson are for students to:

- Make careful observations of protists moving.
- Practice using a microscope.

A microscope that is small and easy for young children to handle is recommended for this experiment. You may need to help your students learn how to look through a microscope lens. For practice, it might help to have the students look at larger objects, such as a piece of paper with lettering they can see. This will help the students orient their eyes for observing small things through the eyepiece. Before beginning the experiment, let them play with the microscope until they are comfortable using it.

Experiment

I. Think About It

Read this section of the *Laboratory Notebook* with your students.

The students have read about how protists move. Now have them think about what movement for a protist might look like and what looking at pond water through a microscope might show. Help them explore their ideas with questions such as:

- *What do you think pond water looks like?*
- *Will you see moving creatures?*
- *Do you think you will be able to tell if they are moving? How?*
- *Do you think you will see them rolling or twisting?*
- *Do you think they will swim fast or slow? Straight or in a circle?*
- *What else do you think you might observe in pond water?*

Have them draw what they think they will see when they look at pond water through a microscope. There are no right answers—just let students explore their ideas.

II. Observe It

Read this section of the *Laboratory Notebook* with your students.

This is mainly an observational experiment.

❶ **a)** Help the students set up the microscope. Placing the microscope on a flat, firm surface will make it easier to use.

b) Help the students put a drop of protozoa water (or pond water or hay water) on a plastic slide.

c) Help the students carefully place the slide in the microscope.

d) Help the students look through the eyepiece at the water on the slide.

It may take several tries before protists can be observed. Help students repeat setting up the slide with samples as many times as necessary.

It is important for students to practice observing as many different details as possible. Have them draw their observations.

❷–❺ There are several drawing frames in the *Laboratory Notebook* for students to fill in with drawings of the different features they observe in the pond water. Encourage them to spend plenty of time looking at all the different features they observe. You can encourage them to stay at the microscope by engaging them with questions such as:

- *What kind of protist do you think you are seeing?*
- *Is it moving fast or slowly? Can you see it spin?*
- *How does it stop? Can it move backwards?*
- *Do you see an amoeba?*
- *How fast does an amoeba move?*

❻–❼ Have students compare some of the protists they are observing. They are asked to make comparisons between different protists of the same kind (two paramecia, for example) and protists of different kinds (possibly a paramecium and an amoeba).

III. What Did You Discover?

Read this section of the *Laboratory Notebook* with your students.

Have the students answer the questions about the protists they observed. Encourage them to refer to their notes in the *Observe It* section and summarize their answers based on their observations. They should have been able to see different protists moving in different ways. Have them explain what their favorite protist was and why. Help them notice any differences between what they thought they would observe and what they actually observed.

IV. Why?

Read this section of the *Laboratory Notebook* with your students.

There are many different kinds of protists. Depending on what your students used for protozoa water, they should have been able to observe at least two different kinds of protists.

Protists move like sophisticated little machines. They roll and spin, stop and start, move forward, and back up. Explain to the students how remarkable protists are since they are made with only one cell yet can do so many different things.

V. Just For Fun

Have the students put some saliva on a slide and look at it under the microscope to see if they can find any organisms. Have them record their results.

Experiment 19

Tracking a Constellation

Materials Needed

- colored pencils
- night sky
- daytime sky or textured surface

Optional

- book or online information about constellations
- globe or basketball

Objectives

In this experiment students will observe a constellation of their choice to see whether its position changes in the night sky over the course of a week.

The objectives of this lesson are to have students:

- Make careful observations.
- Use their eyes as a tool in a scientific experiment.

Experiment

I. Think About It

Read this section of the *Laboratory Notebook* with your students.

Have the students answer the questions in this section. There are no right answers. Guide open inquiry with questions such as the following.

- *Do you think every star you can see is part of a constellation? Why or why not?*
- *Do you think there are lots and lots of constellations? Why or why not?*
- *Do you think people are coming up with new constellations all the time? Why or why not?*
- *If you look at the sky at different times of the night, do you think you will always see the stars in the same position? Why or why not?*
- *Do you think you would see the same groups of stars no matter where you are on Earth? Why or why not?*
- *From what location on Earth do you think you could see the most constellations? Why?*

II. Observe It

Read this section of the *Laboratory Notebook* with your students.

❶ Have the students pick a constellation to observe. To find more constellations than those mentioned in the *Student Textbook*, they can consult a book about constellations or look online for more information. Guide them in selecting a constellation that will be visible at the time they will be looking for it.

❷ Help the students locate the constellation they have chosen to observe. If they can't find it on the first night, have them try again the next night or several nights until they can see it.

❸ Have the students record the time and date when they first see their constellation. For the following six days they will view the constellation at the same time.

❹ A box is provided for students to record the position of the constellation by drawing or writing. Have them observe how high in the sky the constellation is and in which direction. It can be helpful to have them note a landmark to use to track the relative position of the constellation during the experiment—for example, how the constellations is positioned over a fence post, tree branch, or corner of a building.

❺ Have the students observe the constellation at the same time for six more days and record their observations about its location. If it's too cloudy to see the constellation, they can either note this for that day's observation or they can observe the constellation on six clear nights even if there are days in between the observations.

III. What Did You Discover?

Read this section of the *Laboratory Notebook* with your students.

Have the students answer the questions. Answers will be based on their observations.

IV. Why?

Read this section of the *Laboratory Notebook* with your students. Answer any questions that may come up.

If you have a globe, it can be used to demonstrate how the spin of Earth on its axis changes the view of the constellations during the course of a night. A globe can also be used show how the constellations that are visible at any one time varies according to one's location on Earth and how most or possibly all constellations will be visible from the equator. In addition, the globe can be used to show how Earth's orbit around the Sun changes Earth's position relative to the constellations and thus changes our view of the stars over the course of a year. A basketball or other ball may be used instead of a globe.

Although over time the stars do change their position in the universe relative to Earth, this happens so slowly that it isn't obvious in a lifetime.

V. Just For Fun

In this experiment students look at clouds and use their imagination to find shapes that remind them of some person, animal, or other object. Then they are asked to draw a picture of what they see and write a short story about it. The story can be one sentence or longer—wherever their imagination takes them. It can be fiction or nonfiction.

If there are no clouds, help students find a textured surface that provides enough variation to suggest different shapes.