Exploring The BUILDING BLOCKS of SCIENCE

Book 1

STUDENT TEXTBOOK

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REAL SCIENCE 4 Kids

Illustrations: Janet Moneymaker

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Contents

Introduction

Chemistry

Biology

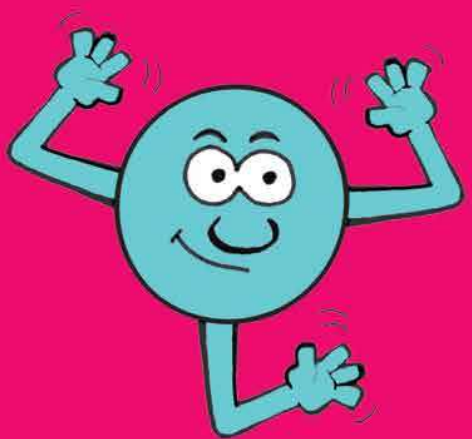
Physics

Geology

Astronomy

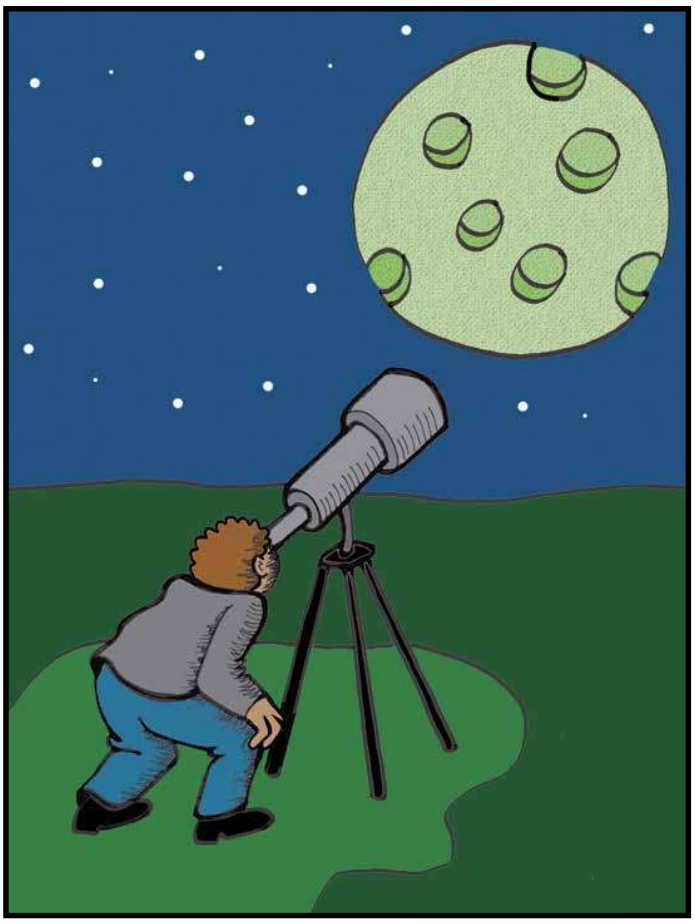
Conclusion

Chapter 3 Atoms



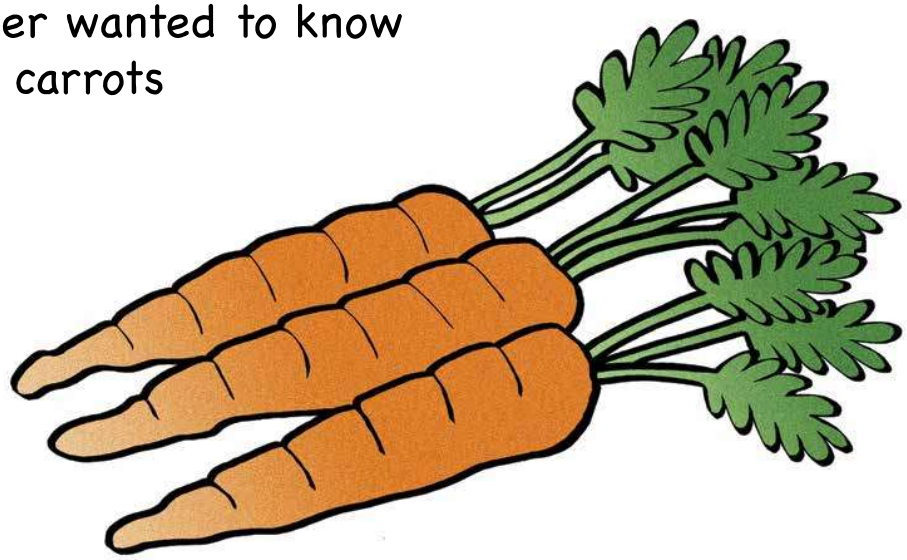
3.1 Atoms

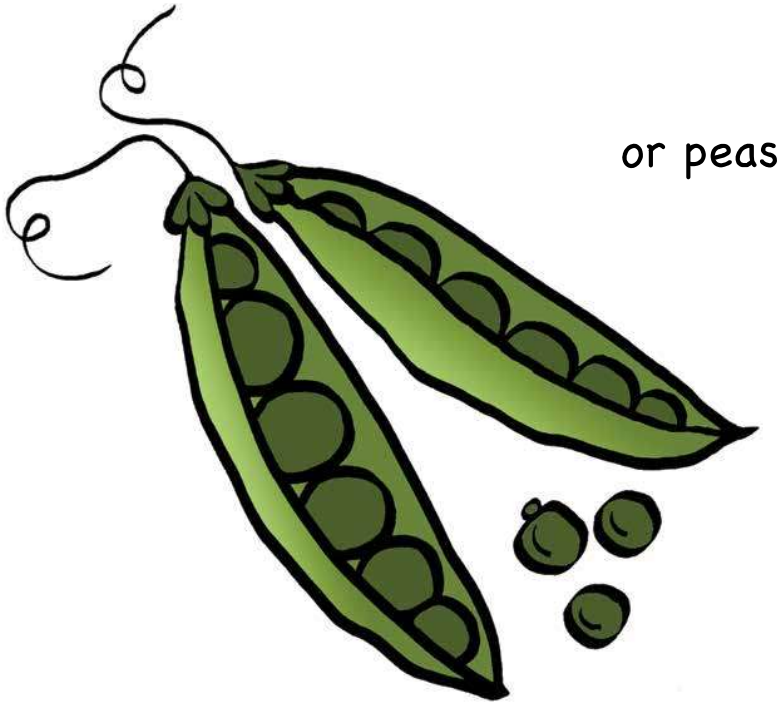
Have you ever wondered if the Moon is really made of green cheese?



Have you ever thought the clouds might be made of cotton candy?

Have you ever wanted to know what makes carrots orange...

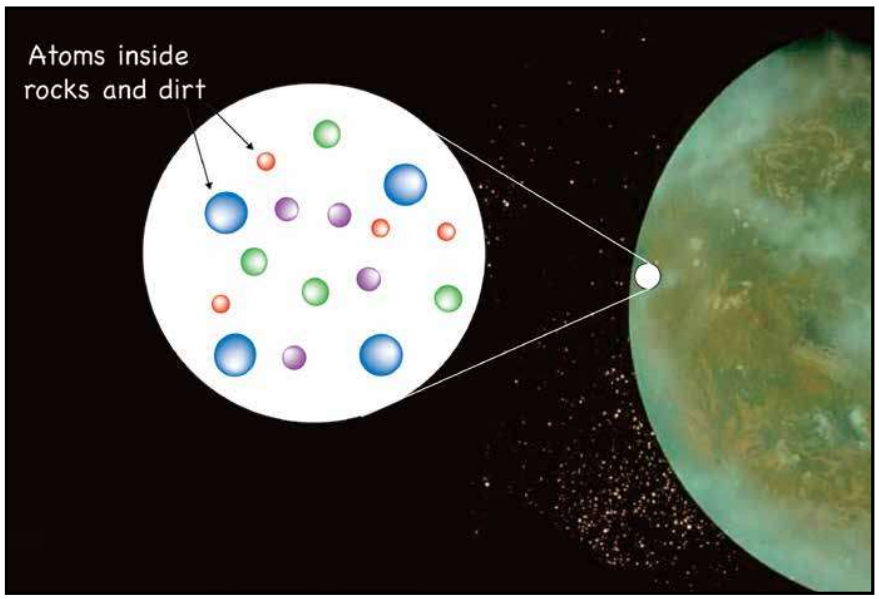




or peas green?

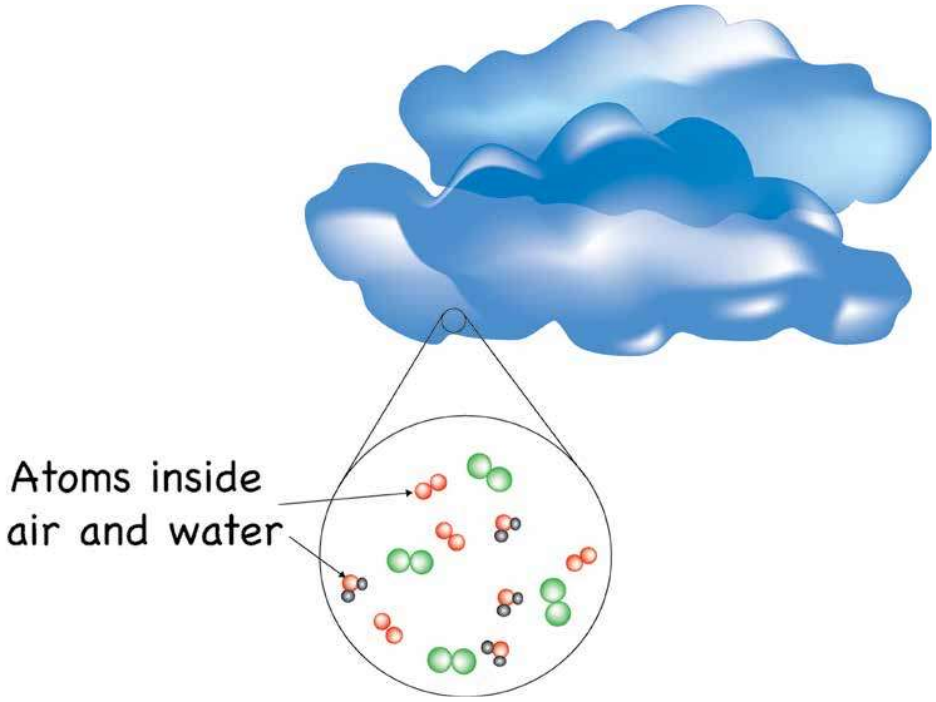
Have you ever wondered why brussels sprouts couldn't taste more like sweet cherries, or asparagus taste more like candy canes?

Everything around us has a different shape or flavor or color because everything around us is put together with different combinations of atoms. An atom is the smallest unit that makes up matter. Atoms can combine with one another in different groupings to make different substances.



The Moon is not really made of green cheese. It is made of the kinds of atoms that are found in rocks and dirt.

Clouds are not made of cotton candy, but of the kinds of atoms that are found in air and water.



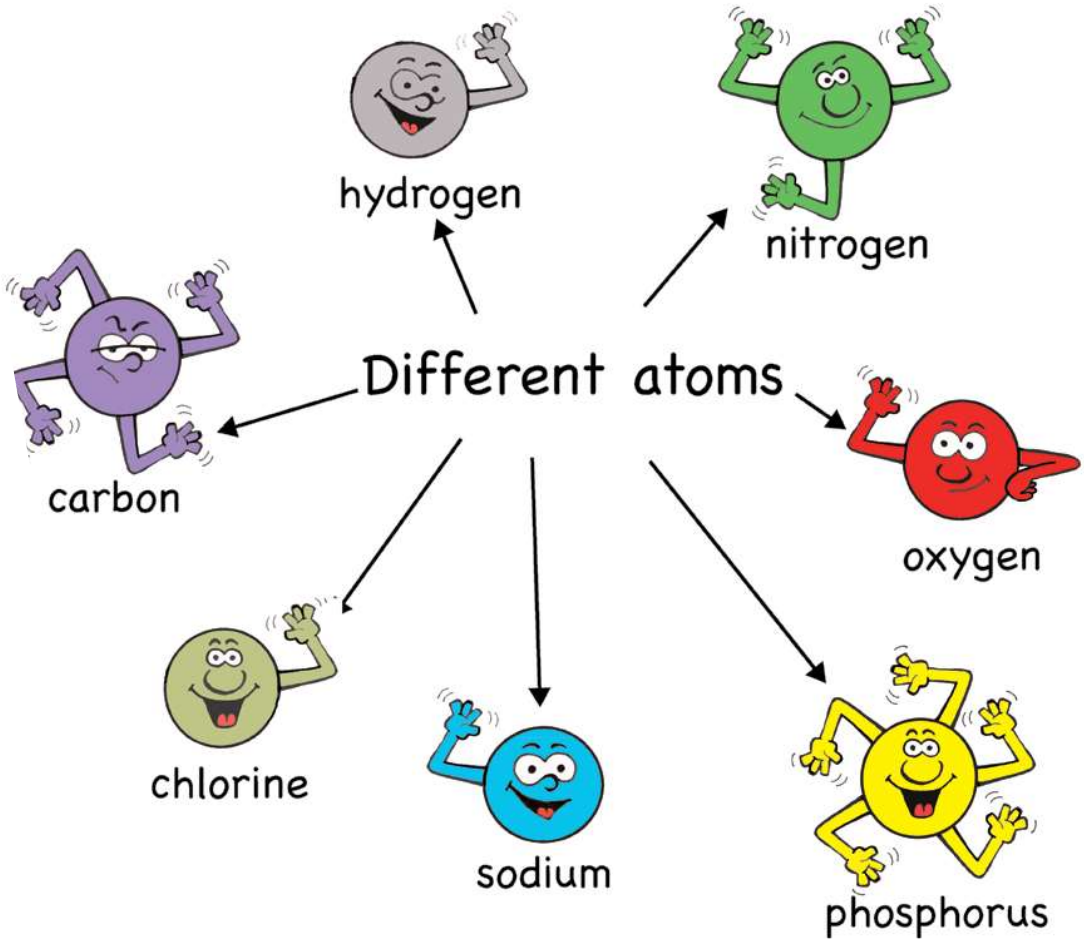
Carrots are orange because their atoms are arranged in a way that makes them orange.

Peas are green because their atoms are arranged in a way that makes them green.

Brussels sprouts and asparagus don't taste sweet like cherries or candy canes because the atoms inside brussels sprouts and asparagus are not arranged in a way that makes them sweet.

3.2 Types of Atoms

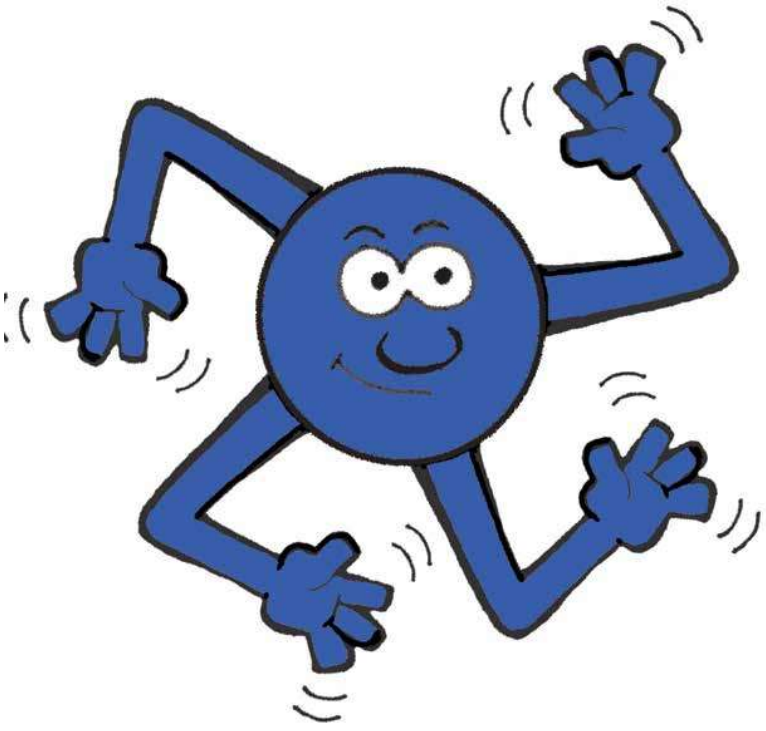
There are over 100 different atoms. Carbon, oxygen, and nitrogen are the names of a few of these atoms.



Atoms are very tiny. They are so small that you can't see them with your eyes.

Even though we can't see atoms with our eyes, we can make models of them. Remember from Chapter 2 that a model may not be exactly true but it can help chemists understand how things work. We can make models of atoms by drawing them as dots or little balls or by giving atoms colors and shapes.

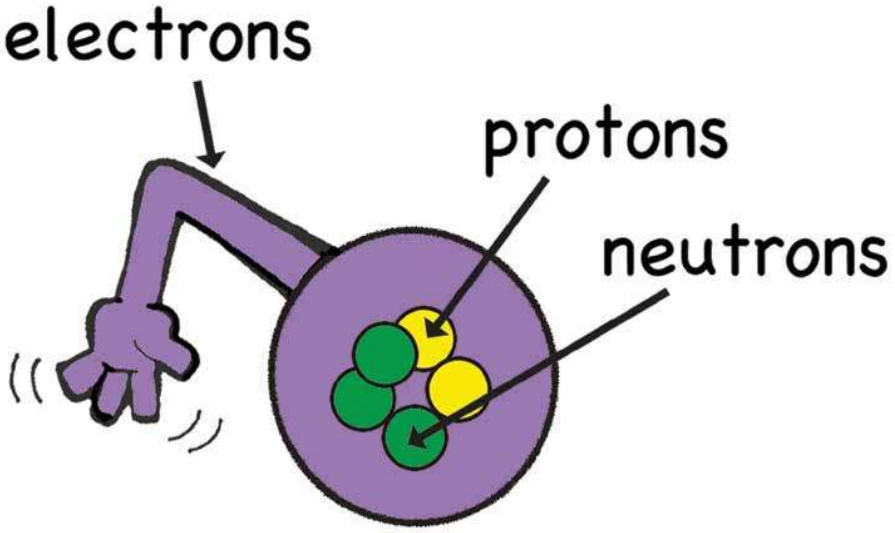
In this book, atoms are modeled as balls with "arms" to help show how atoms hook to other atoms. Even though atoms don't really have arms, it's a great way to think about how atoms hook together.



Simple Model of a Silicon Atom

3.3 Atoms Are Similar

All atoms are made of protons, neutrons, and electrons.



Protons, neutrons, and electrons are the basic parts of atoms. The protons and neutrons are in the center of an atom, and the electrons are on the outside.

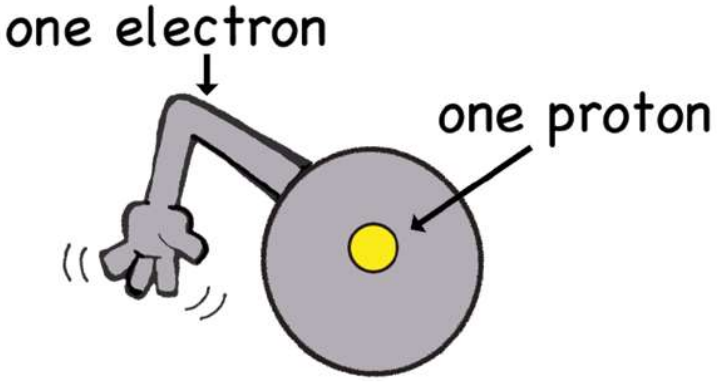
In our model, the protons and neutrons are shown inside the ball of the atom, and the electrons are shown on the outside as the arms.

The arms in our models represent only the electrons that can help hook an atom to another atom. Some atoms have additional electrons that won't hook to another atom, and these electrons are not shown in our models.

3.4 Atoms Are Different

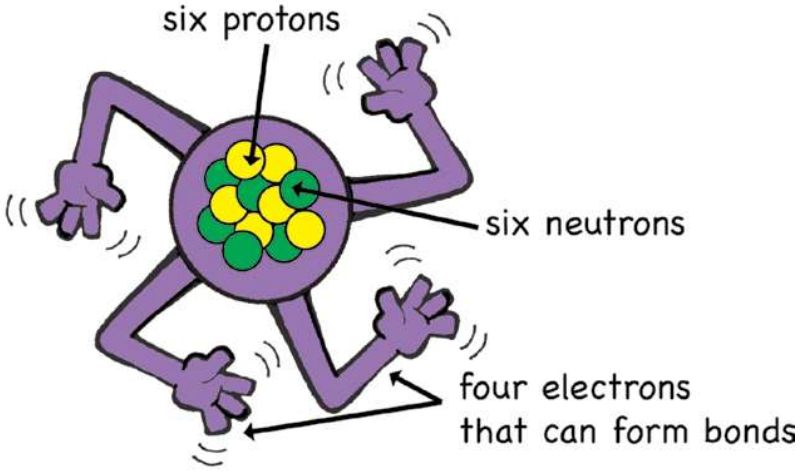
Atoms are different from each other because they have different numbers of protons, neutrons, and electrons.

For example, hydrogen only has one proton and one electron. It doesn't have any neutrons.



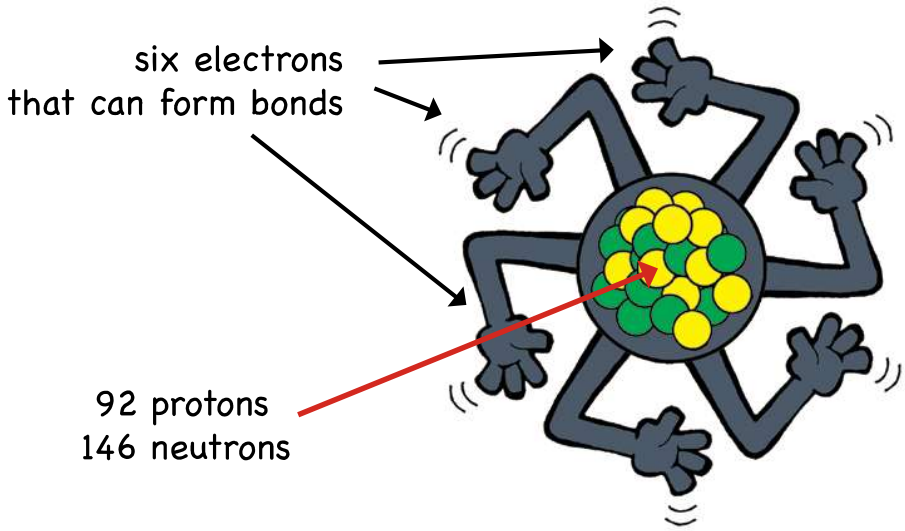
Model of a Hydrogen Atom

Carbon has six protons, six neutrons, and six electrons. However, only four of those electrons can help carbon hook to other atoms, so in our model carbon has only four arms.



Model of a Carbon Atom

Uranium has 92 protons, 92 electrons, and 146 neutrons! The electrons in uranium can hook to two atoms, four atoms, or even six atoms!



Model of a Uranium Atom

Because atoms are made of the same basic parts, all atoms are similar to each other. But because atoms are also made of different numbers of those parts, atoms are also different from each other.

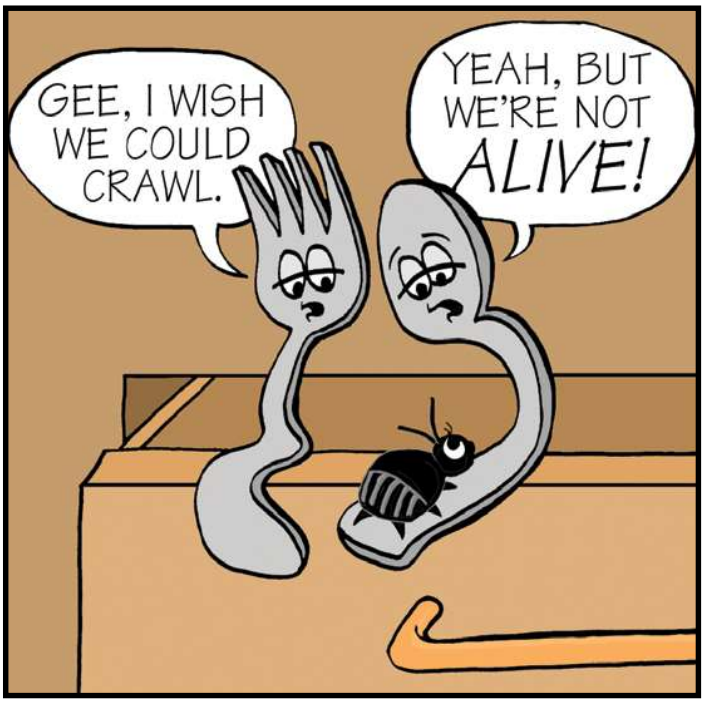
Everything you can touch with your fingers, see with your eyes or smell with your nose is made of atoms. And all of these things are different from each other because their atoms are arranged in different ways.

3.5 Summary

- Everything we touch, taste, see, or smell is made of atoms.
- Atoms are very tiny things we can't see with our eyes. Atoms are the smallest units of matter.
- All atoms are made of protons, neutrons, and electrons.
- Atoms are different from each other because they have different numbers of protons, neutrons, and electrons.

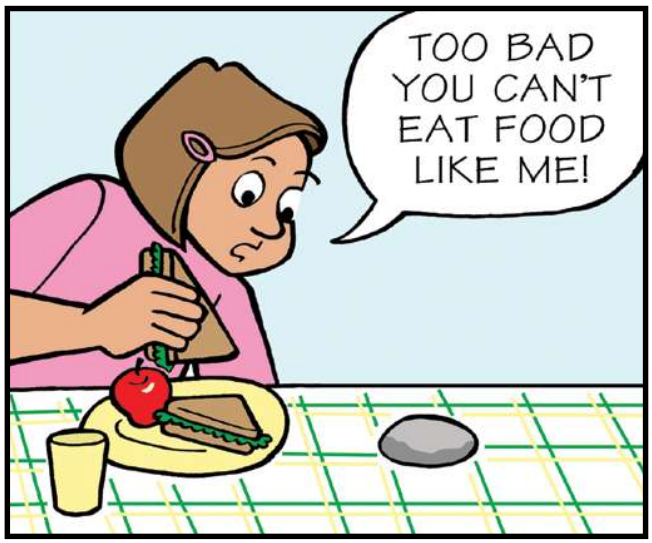
Chapter 7 Life

7.1 Studying Life

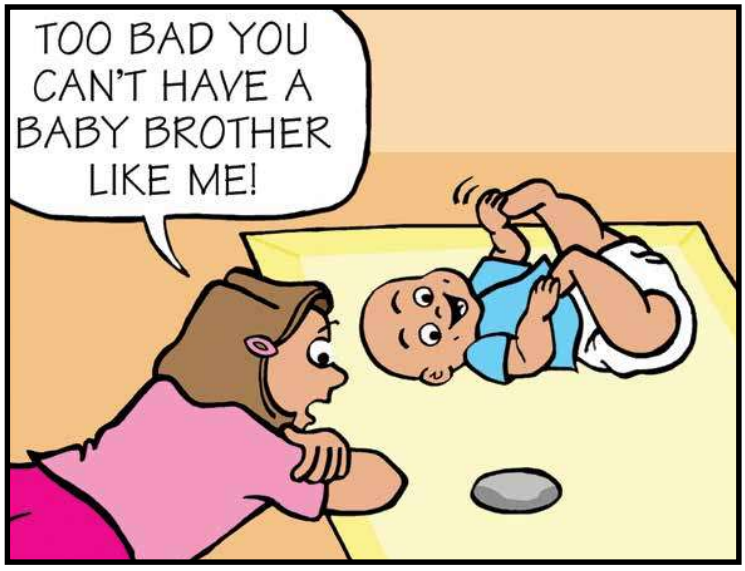


What makes plants, dogs, and beetles different from rocks, dirt, and metal? Maybe you have noticed that rocks don't move like dogs and dirt doesn't need food. Maybe you have seen that forks and knives, which are made of metals, don't crawl around in the kitchen like beetles do. Living things are different from rocks and dirt and metals because living things are alive.

What does it mean to be alive? Think about how you are different from a rock. You need food and a rock doesn't. One feature of being alive is needing food.



Second, you can walk, run, jump, curl up into a ball, and roll on the carpet. But a rock can't move. So another feature of being alive is the ability to move.



Finally, a rock can't make baby rocks, but plants, animals, and humans all make baby plants or baby animals or baby humans. So another feature of being alive is the ability to reproduce.

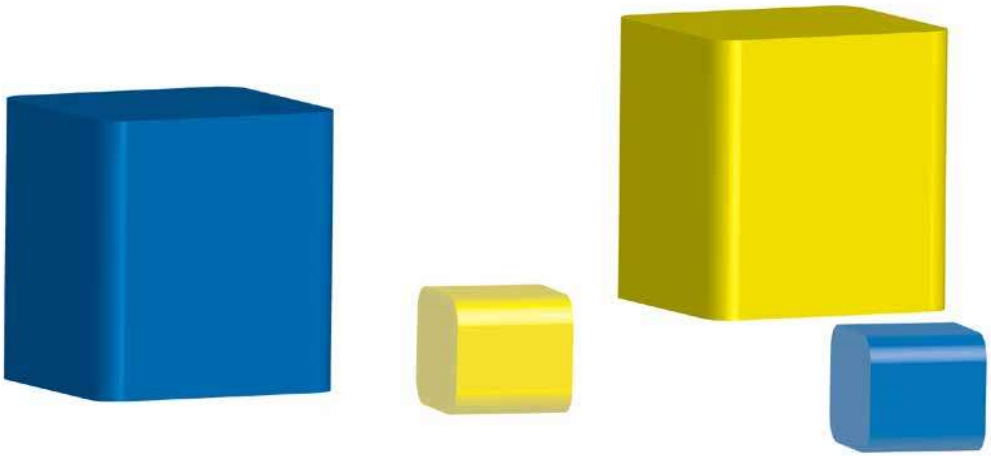
As we can see, living things are much different from nonliving things.

7.2 Sorting Living Things

How do we keep track of all of the living things we find on the planet? Is there a way to sort them? Why would we want to sort them?

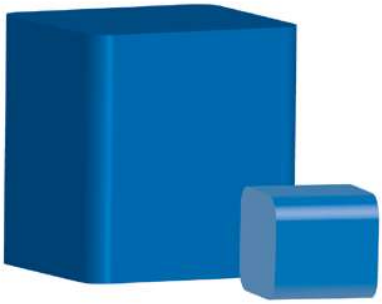
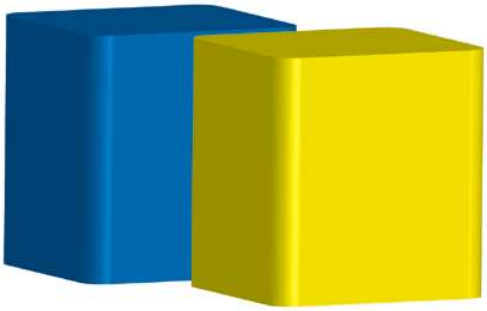
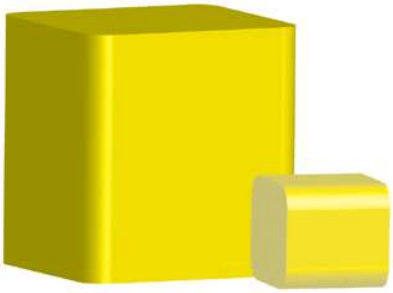
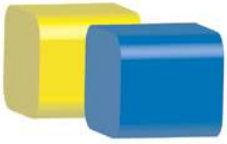
Sorting living things helps us understand how they are different and how they are the same. For example, what if you had some yellow blocks and some blue blocks. How would you sort them?

HOW WOULD YOU SORT THE BLOCKS?



If you sort your blocks according to color, you can see that the blue blocks are different from the yellow blocks. However, you might also notice that some of the blue blocks are the same size as some of the yellow blocks.

So you could also sort them by size. By sorting, you can see how some blocks are different (different color), but also how some are the same (same size).

SAME COLOR	SAME SIZE
 BLUE	 BIG
 YELLOW	 SMALL

A very long time ago a man named Carolus Linneaus thought about how to sort living things. He came up with a system of sorting all of the creatures on the planet. We call this system taxonomy.

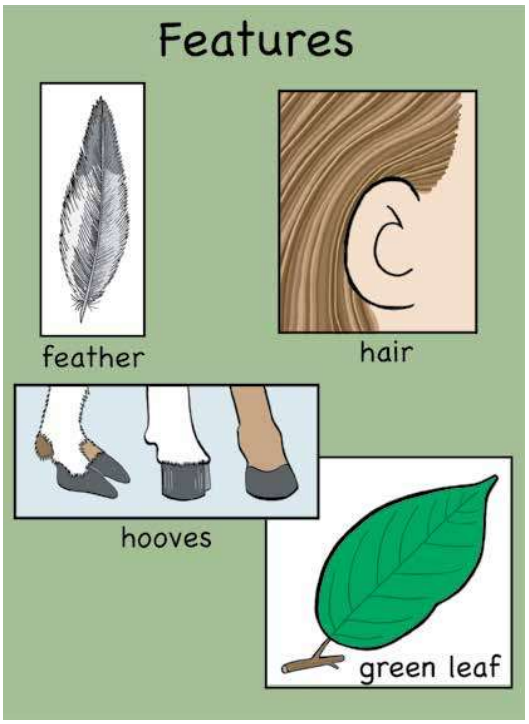
Taxonomy is a branch of biology that is concerned with how to sort living things.

We sort creatures by looking at different features.

A feature is anything like hair, hooves, feathers, or green leaves.

For example, we might sort animals that have hair from animals that don't have hair. We might sort plants that live in the soil from plants that live in the water.

We might also sort very small creatures that we can't even see with our eyes from larger creatures that we can see. Looking at the features of living things helps us sort them.



7.3 Domains and Kingdoms

It is very difficult to decide how to sort living things because they have so many different features! Once upon a time, living things were sorted into only two large groups—plants and animals. However, as scientists learned more about all of the different creatures, they had to make more groups.

House plants are in the kingdom Plantae

Today, scientists use three large groups to sort living things. These groups are called domains. The names of the domains are Eukarya, Bacteria, and Archaea. These domains are then further divided into six kingdoms which are Plantae, Animalia, Protista, Fungi, Bacteria, and Archaea.

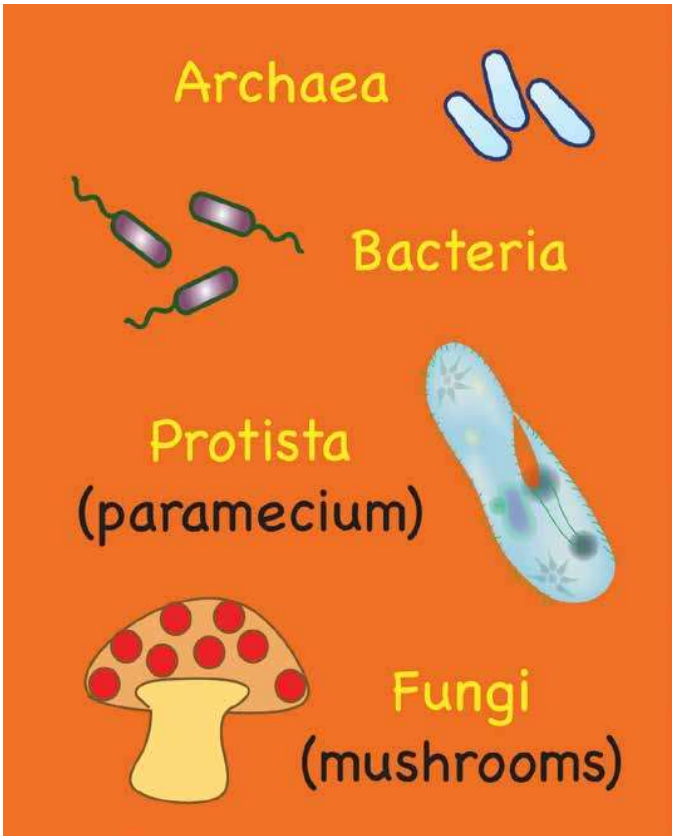
The kingdom Plantae groups all of the plants. Houseplants are in the kingdom Plantae.

Animalia groups all of the animals. Dogs are in the kingdom Animalia. So are cats, frogs, and butterflies.

Bacteria and Archaea are kingdoms that group some of the very small creatures that we can't see when using only our eyes.

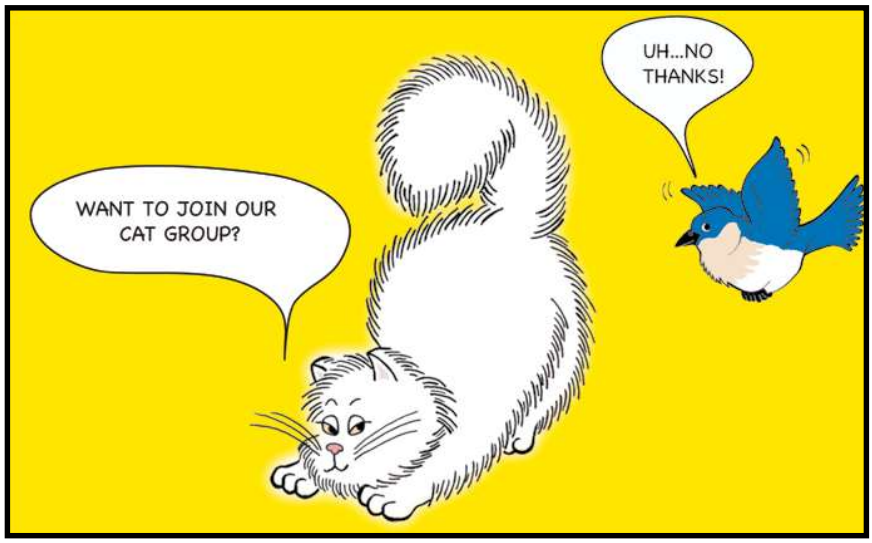
Protista is a group for very small creatures called protists.

And finally, Fungi groups things like toadstools and mushrooms.



7.4 Sorting Within Kingdoms

Scientists first sort living things into their domains and then sort them into their kingdoms. Then scientists organize the living things into smaller groups to better understand them. So, living things in different domains are sorted into kingdoms and then further sorted into smaller, different groups.



To sort living things into smaller groups, scientists again look for different or similar features. For example, both birds and cats are animals, but we can see that birds are different from cats. For one thing, birds have wings and fly, but cats don't fly. Cats have fur and eat birds.

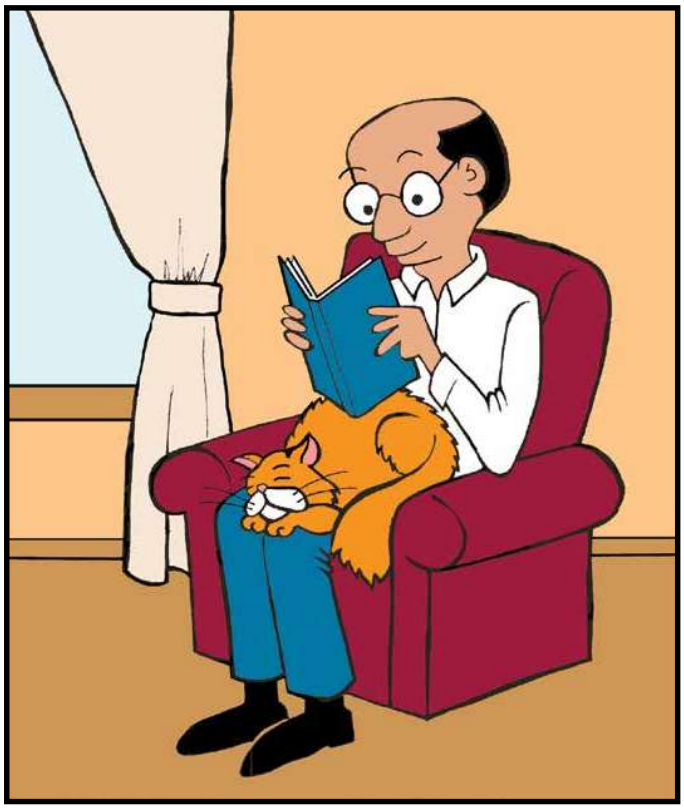
Even though birds and cats are both animals, they are different from each other. All of the birds are put into a group for birds, and all of the cats are put into a group for cats.

What about tigers and house cats? They are both cats. Are they exactly the same? In fact, they aren't. Even though tigers and house cats have some similar features, they are also different. For example, house cats don't usually eat their owners, but tigers could! So house cats and tigers are put into even smaller groups within the larger grouping of "cats."

7.5 Naming

How do we name all of the creatures we find? Because there are so many different languages and so many different living things, scientists use a scientific name to name each living thing. Every plant and animal, fungus, bacterium, and archaeon has a scientific name. The scientific name for each living thing comes from the Latin language. Each creature has two Latin names. The first name is called the genus, and the second name is called the species.

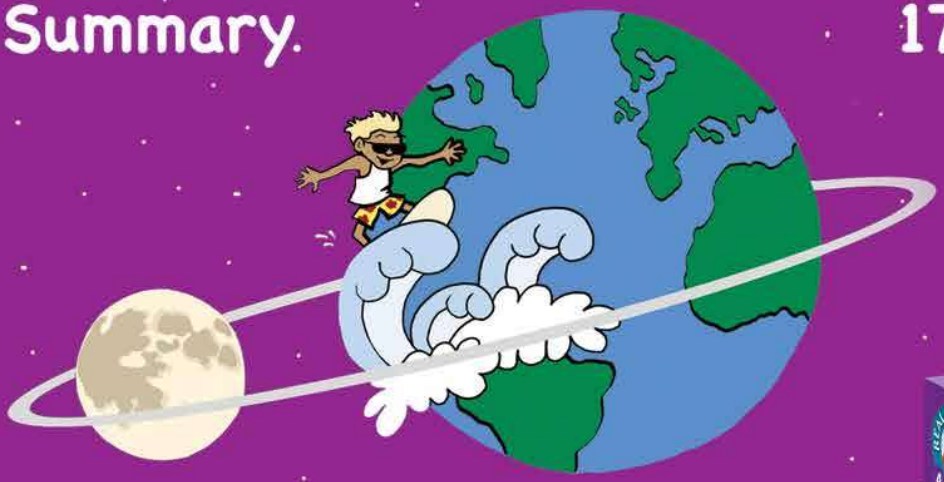
The Latin name for a house cat is *Felis catus,* and the Latin name for humans is *Homo sapiens,* which means "man wise."



7.6 Summary

- Living things are different from nonliving things. All living things need food and can reproduce, and some living things can move.
- Scientists sort living things into groups to understand them better.
- Domains and kingdoms are two kinds of groups that scientists use to sort living things.
- All living things have a special scientific name which is in Latin.

Chapter 19 Earth's Home in Space



19.1 Introduction

Now that we know what astronomy is and how to study planets and stars, it's time to explore what Earth looks like from space.

Because Earth is so big compared to our human size, it's hard to imagine what Earth looks like from space. Is Earth the biggest object in space? Is Earth in the center of space? If we took a rocket into space, what would we find?

19.2 Earth Is a Planet

If you launched a rocket and traveled past the clouds into space, you would see the Earth. Earth would look like a blue marble floating in the dark space around it.

Earth is a planet. A planet has special properties. A planet has to be large enough to have its own gravity, which is the force that holds everything to the Earth's surface. A planet also has to move in space around a sun. And finally, a planet is shaped like a ball. Spherical is the word for ball-shaped.

Because Earth is very large, moves around the Sun in space, has gravity, and is spherical, Earth is called a planet.

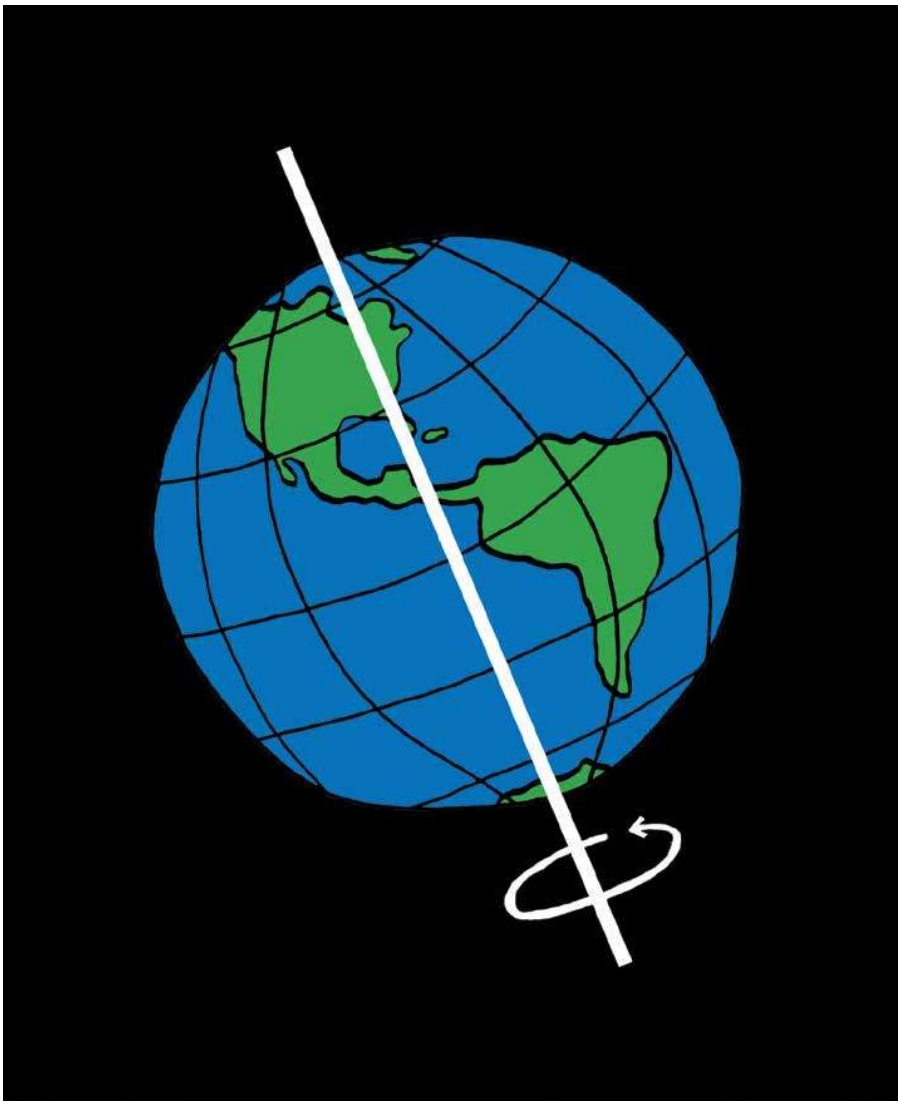
Earth rotates around an axis, which is an imaginary line that goes through the center of an object. If you were to take a ball and spin it with your fingers, it would rotate around an axis.

The Sun shines on different parts of Earth as Earth rotates. This is how we get our days and nights.

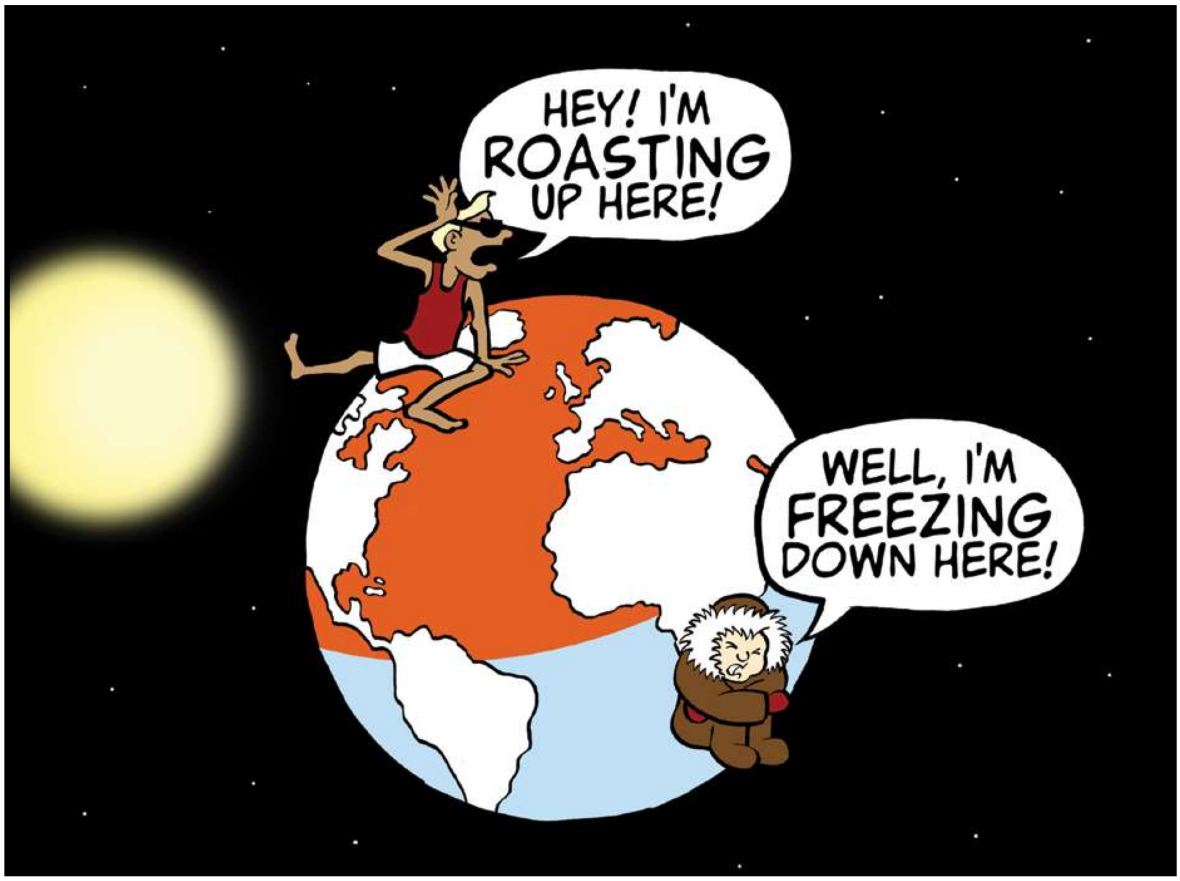
It takes 24 hours for Earth to rotate once around its axis. We don't feel the rotation of the Earth because the Earth's gravity holds down the air and everything else

that's on Earth. Everything is moving at the same speed, and the Earth's rotation does not cause wind.

Earth is tilted on its axis. "Tilted" means that Earth is not just straight up and down but is slanted. The tilt of Earth's axis gives us seasons.



For part of the year, the northern part of Earth is tilted towards the Sun and the southern part of the Earth is tilted away from the Sun. This gives the northern part of the Earth summer and the southern part winter.



Then, during a different part of the year, the southern part of the Earth is tilted towards the Sun and the northern part away from the Sun. When this happens, the southern part of Earth has summer, and the northern part has winter.

19.3 The Moon and Tides

If you take your rocket into space, you might run into the Moon. A moon is an object that travels around a planet. Our moon is smaller than Earth and travels around Earth.

Our moon does have some gravity and is spherical, but because it moves around Earth and not around the Sun as the Earth does, the Moon is not a planet. We will learn more about the Moon in the next chapter.

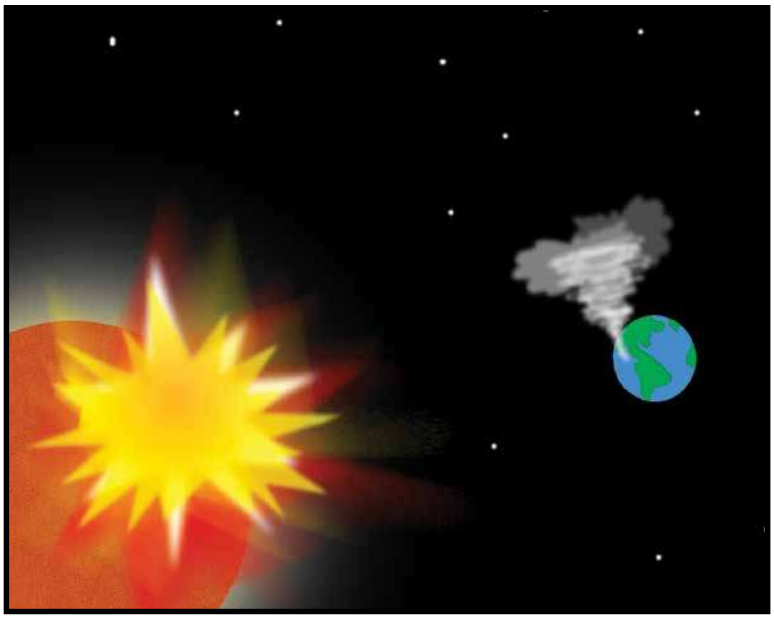
Did you know that the Moon helps create ocean tides on Earth? It's true! The Moon pulls on Earth with some gravity. This pulling on the Earth causes the water in the oceans to be pulled too.

As the Moon moves around the Earth, it pulls the ocean water with it. The pulling of ocean water by the Moon helps create tides.

19.4 The Sun and Weather

If you wear sandals during a summer day, you can feel the Sun warming your toes. The Sun is a big ball of fire that gives light and heat energy to Earth.

The Earth orbits the Sun. The word orbit means to "revolve around." An orbit is the path one object makes as it travels around another object. If you stand with your hand on a pole and then start walking, you will make a path around the pole. You will orbit the pole. This is what Earth does as it moves around the Sun. We will learn more about the Sun in the next chapter.



Did you know there are storms on the Sun? Did you know that the storms on the Sun can cause storms on Earth? It's true! Sun storms can contribute to Earth storms. Scientists who research weather can study Sun storms to find out how they affect Earth's weather.

19.5 Eclipses

During the Moon's orbit around Earth, the Moon travels behind the Earth. When the Earth is in between the Moon and the Sun, the Earth can block the Sun's light from reaching the Moon. When the Earth's shadow is cast on the Moon, it is called a lunar eclipse.

At other times, the Moon will be in between the Sun and the Earth. With the Moon in this position, the Moon can block the Sun's light from reaching a portion of the Earth. This is called a solar eclipse.

19.6 Summary

- Earth is a planet.
- One rotation of the Earth on its axis takes 24 hours (one day).
- Earth is tilted on its axis, giving us seasons.
- The Moon and Sun affect Earth's tides and weather.

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Book 1

LABORATORY NOTEBOOK

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Contents

Experiment 3

What Is It Made Of?

I. Think About It

Write down the name of an object. Using words and drawings, describe any features you think it has.

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

II. Observe It

Write down the name of the object you thought about. Describe what you actually see, using words and drawings.

I. Think About It

Write down the name of an object. Using words and drawings, describe any features you think it has.

II. Observe It

Write down the name of the object you thought about. Describe what you actually see, using words and drawings.

I. Think About It

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_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

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I. Think About It

Write down the name of an object. Using words and drawings, describe any features you think it has.

II. Observe It

Write down the name of the object you thought about. Describe what you actually see, using words and drawings.

III. What Did You Discover?

❶ Were the objects you looked at the same as you expected them to be or were they different?

❷ How were they the same as you expected?

❸ How were they different from what you expected?

❹ Did you expect the objects to be the same on the inside and the outside or to be different?

❺ Which ones were the same on the inside and the outside?

❻ Which ones were different on the inside and the outside?

IV. Why?

When we look at things around us, we often don't notice the small details. In fact, some things are too small to see with our eyes. Atoms, for example, are too small to see with our eyes, but by doing experiments scientists have discovered that everything is made of atoms.

When we take the time to look for small details, we often find amazing things we have never seen before. For example, we notice that some of the things we see are similar to each other. Different kinds of crackers, for instance, have some things that are the same as each other. Many crackers are square or round and the crackers in one box are often the same shape.

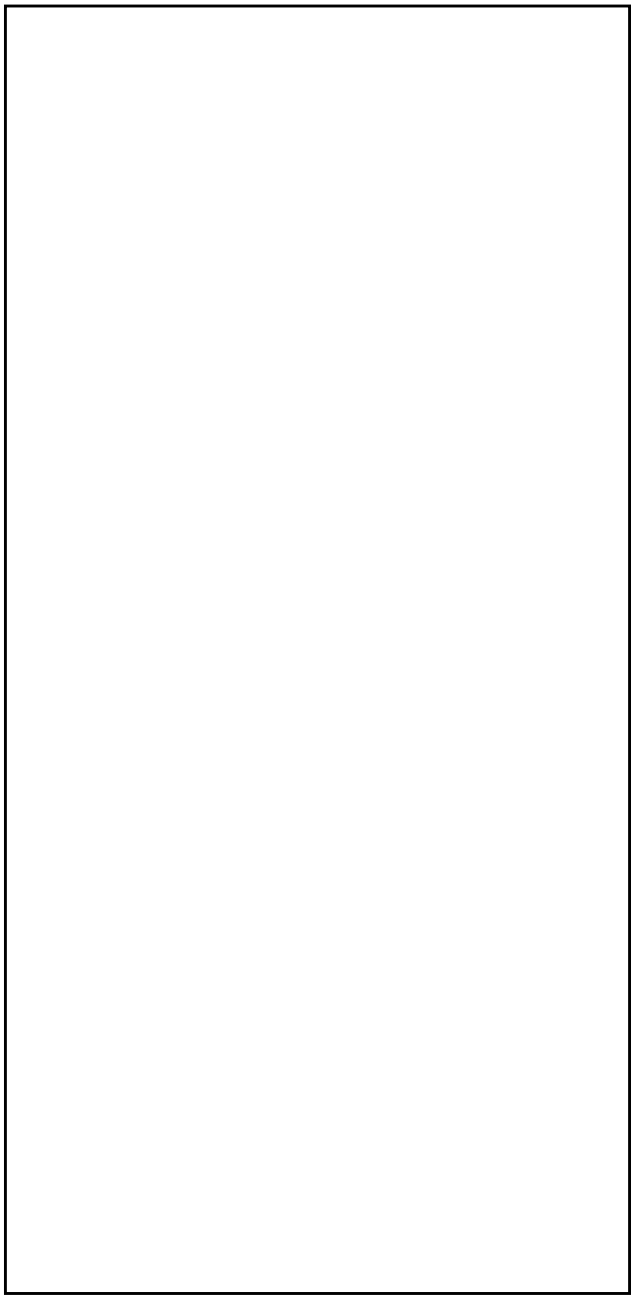
However, we also notice that even though two things may seem the same, they are not exactly the same. No two round crackers are exactly the same, and no two square crackers are exactly the same. Each one is unique. We can see the ways in which things are unique when we look at the little details.

The same is true of you. You may look similar to your mom or dad, sister or brother, but you are not exactly the same. You, too, are unique.

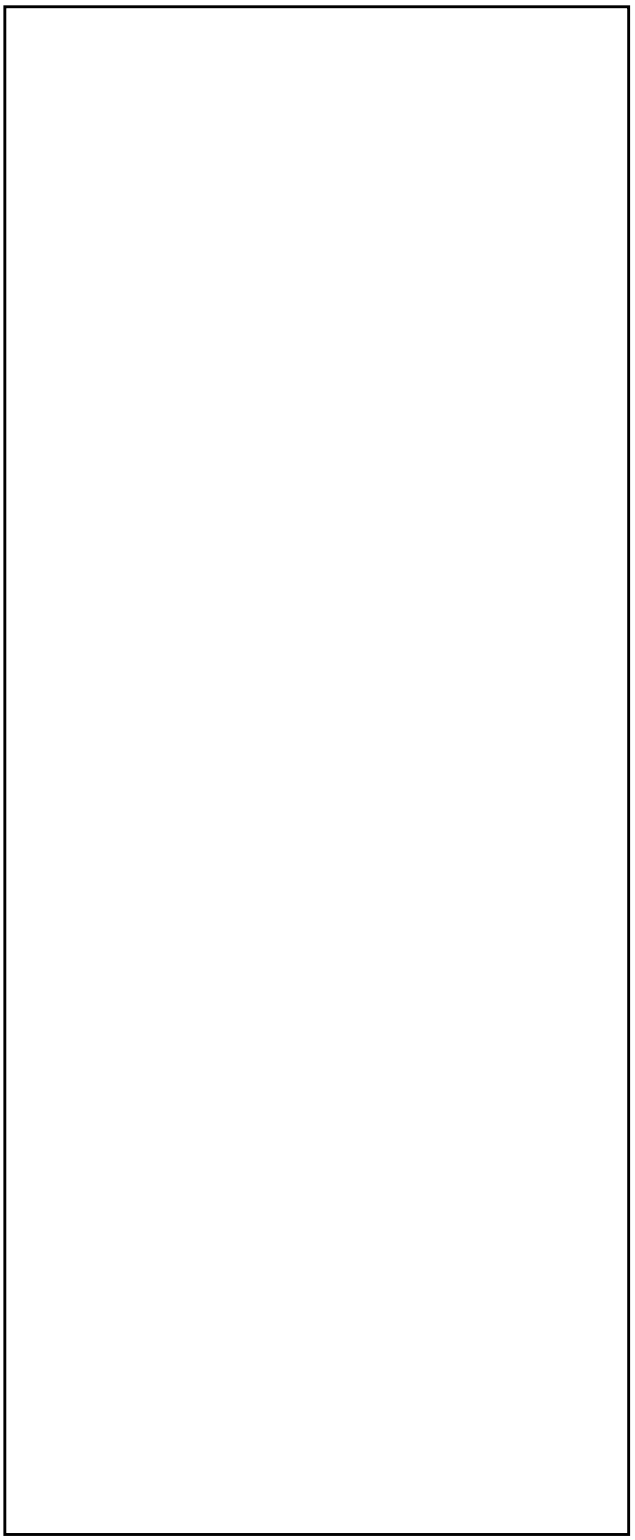
V. Just For Fun

Think of a family member or friend. What things can you observe that are similar about you and the other person? What things are different?

List or draw things that are similar.



List or draw things that are different.



Experiment 7

Where Does It Go?

I. Observe It

❶ Collect some different objects to observe.

❷ Look carefully at the objects and make observations about them.

❸ In the spaces provided, name each object and describe each in detail using words or pictures.

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

II. Think About It

❶ Look at all of the objects you described. Think about different groups you might use to sort them. You might use small or round or white or fuzzy.

❷ Name five groups you will use to sort the objects. Put the name of each group in the gray box. Put each object in **ONE** group only.

❸ Are there objects that fit in more than one group? If so, re-sort as many objects as you can into new groups.

❹ Can you do it again?

III. What Did You Discover?

❶ What did you observe about the objects you collected?

❷ Was it easy to pick groups to sort the objects? Why or why not?

❸ Was it easy to decide which objects would go in each group? Why or why not?

❹ The objects in a group have the same feature (for example, round or small). List some features that were different between objects in the same group.

The _____ objects
were all _____ but some
were also _____.

The _____ objects
were all _____ but some
were also _____.

The _____ objects
were all _____ but some
were also _____.

The _____ objects
were all _____ but some
were also _____.

The _____ objects
were all _____ but some
were also _____.

IV. Why?

It can be hard to sort objects into groups. Some round objects may also be fuzzy, like a cotton ball. And some other round objects might be smooth like a rubber ball. Some smooth objects might also be large. And some smooth objects might also be small. How do you decide which object to put in which group?

This can be a difficult problem, even for scientists. Living things have lots of different features, and it can be hard to figure out which living things go in which groups. Do you sort all the green creatures in one group and all the brown creatures in another group? This would be one way to sort green grass and bears. But what about a tree? A tree is both green and brown. Does a tree go with the grass or with the bears?

Scientists sometimes discover a new living thing—a creature they have never seen before. The first thing a scientist does is make careful observations about the creature. Is it green or gray? Does it have smooth skin or scaly skin? Does it live in the water, or does it live on land? Does it eat vegetables, or does it eat other animals? Can you see it with your eyes, or do you need to use a microscope to see it?

All of these observations help scientists know which group a new creature should go into. By putting it into a group, scientists can better understand what is the same and what is different about the new creature compared to other creatures.

V. Just For Fun

You are an explorer traveling to places on Earth where no one has been before. In one of these remote areas, you find a new creature that no one knows about. It has the following features.

- It is green.
- It eats flies.
- It lives in trees.
- It flies with wings.

If you had to put your new creature into a group, would you group it with frogs, monkeys, or butterflies?

Draw a picture of this new creature.

The scientist who discovers a new living thing gets to name it. What would you name this creature you found?

A New Creature

Experiment 19

Earth in Space

I. Observe It

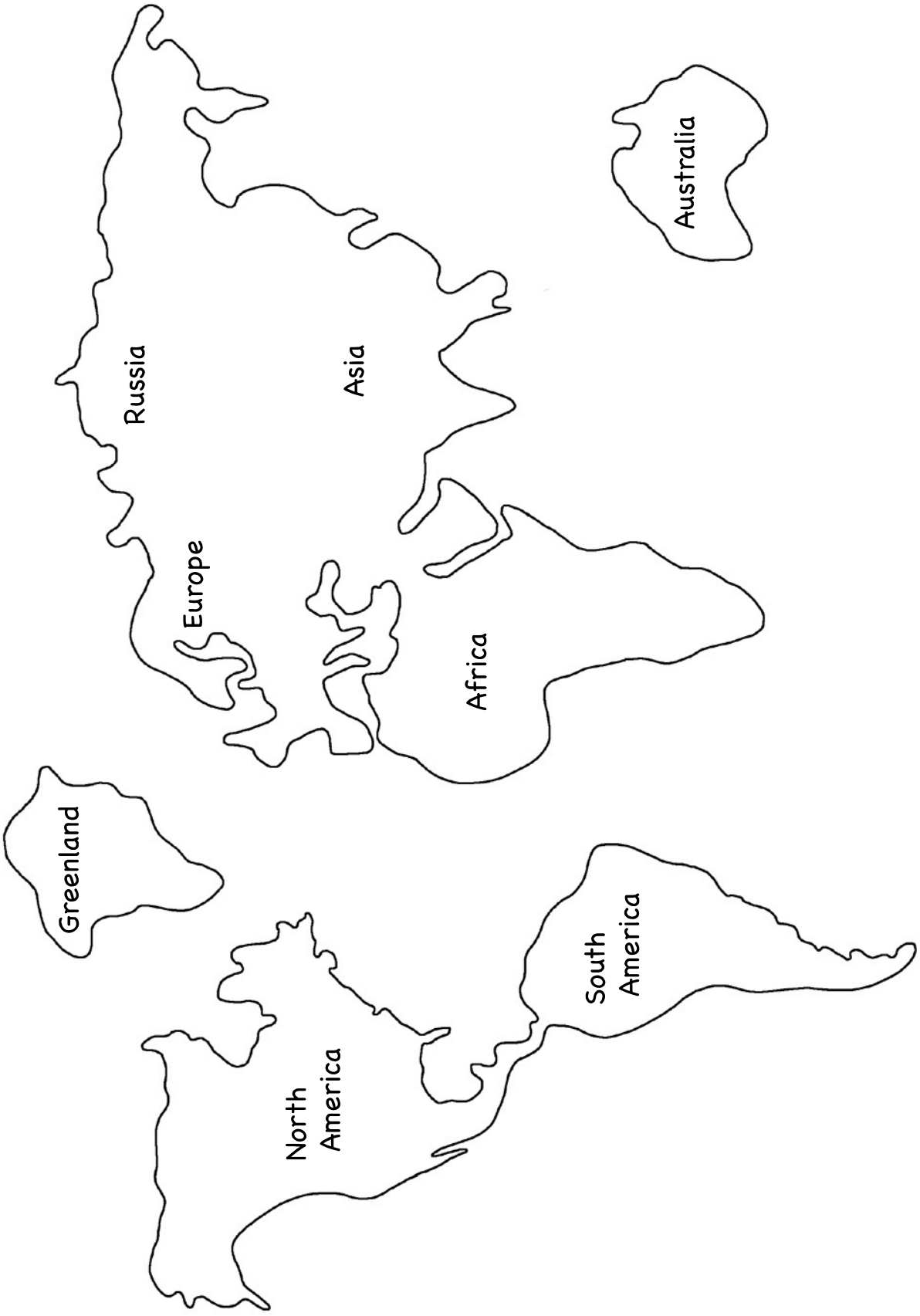
❶ Cut out the continents on the following page.

❷ Glue or tape the continents onto a large basketball with North America, South America, and Greenland on one side and Australia, Africa, Europe, Russia, and Asia on the other side.

❸ Cut a 2.5 cm (one inch) wide piece from the end of a toilet paper tube. This will give you a nice ring to place the basketball on. When you place the basketball on this cardboard ring, tilt the ball slightly off-center.

❹ Turn off the room lights. Walk several feet away from the basketball and shine light from a flashlight on the basketball.

❺ Leaving the flashlight shining on the basketball, rotate the basketball counterclockwise. Record your observations below.


Russia
Asia
Australia
Europe
Africa
Greenland
South America
North America

❻ Hold a ping-pong ball a short distance away from the basketball. Move the ping-pong ball in a counterclockwise circle around the basketball. Record your observations below.

II. Think About It

❶ Can you determine how day and night are created by the rotation of Earth?

❷ Can you observe how a lunar eclipse forms (where Earth casts a shadow on the Moon)?

❸ Can you observe how a solar eclipse forms (where the Moon casts a shadow on Earth)?

❹ Using the basketball and flashlight, can you show how the seasons are created? Explain how you would do this.

III. What Did You Discover?

❶ Explain how day and night occur.

❷ Explain how a lunar eclipse occurs.

❸ Explain how a solar eclipse occurs.

❹ What causes the different seasons?

IV. Why?

In this experiment you observed what happens when the Sun shines on the Earth and the Moon. In this experiment the Sun is represented by the flashlight, Earth is represented by the basketball, and the Moon is represented by the ping-pong ball.

When you rotated the basketball (Earth), the flashlight (Sun) was shining on different parts of the ball. This action, (the Sun shining on a rotating Earth) is what causes night and day.

When you took the ping-pong ball (Moon) and rotated it around the basketball (Earth), you observed how the Moon casts a shadow on Earth when the Moon is between the Sun and the Earth. This illustrates a solar eclipse. You also observed how the Earth casts a shadow on the Moon when the Earth is between the Sun and the Moon. This arrangement illustrates a lunar eclipse.

You also found out how seasons occur. The Earth's tilt causes the seasons. As the Earth circles the Sun, some parts of Earth are tilted toward the Sun, receiving more heat energy, and some parts are tilted away, receiving less heat energy. This tilting of the Earth creates seasons as different parts of Earth are tilted toward or away from the Sun.

V. Just For Fun

☼ Think about what it would be like if the Earth's axis still had the same tilt but the axis went through the equator instead of going through the North and South Poles. Would this change the seasons? Would it change night and day?

Try using the basketball and the flashlight to experiment with this idea.

Observations

☼ Next, think about what would be different if the Earth's axis still went through the North and South Poles but was pointed directly at the Sun. Would this change the seasons where you live? Would it change night and day?

Try using the basketball and the flashlight to experiment with this idea.

Observations

Exploring The BUILDING BLOCKS of Science

Book 1

TEACHER'S MANUAL

REBECCA W. KELLER, PhD

REAL SCIENCE 4 Kids

Exploring the Building Blocks of Science Book 1 Teacher's Manual
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A Note From the Author

This curriculum is designed to provide an introduction to the sciences for students in kindergarten through first grade. The *Building Blocks of Science Laboratory Notebook: Book 1* is intended to be the first step in developing a framework for real science. This teacher's manual will help you guide students through the laboratory experiments. The series of experiments in the *Laboratory Notebook* will help the students develop the skills needed for the first step in the scientific method — making good observations.

There are different sections in each chapter. The section called *Observe It* helps the students explore how to make good observations. The *Think About It* section provides questions for the students to think about and to use to make further 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 there is a section called *Just For Fun* that contains an additional activity.

The experiments take up to 1 hour. The materials needed for each experiment are listed on the next page 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
colored pencils night sky a living thing to observe (frog, ant, plant, or other)	magnifying glass household items such as: cotton balls rubber bands pencil several food items such as: crackers cheese marshmallow beans color-coated candy (such as M&Ms)	Legos marshmallows, small (1 pkg) marshmallows, large (1 pkg) toothpicks	4 or more clear plastic cups or glasses marking pen measuring cup measuring spoons food items-180 ml (3/4 cup) each: lemon juice vinegar milk water baking soda - 90 ml (6 Tbsp.) *Just For Fun* section: baking soda vinegar sugar -Or- 2 or more food items chosen by student	non-living object to observe (such as a rock or piece of wood) living thing to observe (such as an ant, frog, bird, cat, or dog) colored pencils
Experiment 2 watercolor paints water in a container paintbrush paper to paint on, several sheets scissors tape				

Experiment 7	Experiment 8	Experiment 9	Experiment 10	Experiment 11
cotton balls rubber ball tennis ball banana apple rocks Legos other objects colored pencils	internet access and/or reference books colored pencils	milk, .25 l (1 cup) plain yogurt, .5 liter (2 cups) fork spoon cups or small bowls (several) food items such as honey, berries, chopped fruit or vegetables, spices, herbs, cocoa, chocolate chips, etc. (*Just For Fun* section)	2 tennis balls other objects such as: apple orange rubber ball cotton ball or feather	large marshmallow tennis ball objects such as: rubber ball lemon or lime rock banana pliers

Experiment 12	Experiment 13	Experiment 14	Experiment 15	Experiment 16
toy car stiff cardboard or board (approximately .3 meter wide x 1 meter long [1 foot x 3 feet]) marshmallows (several) **Optional** pennies tape	2 marbles 3 playing cards shallow jar top vinegar baking soda measuring spoons **Suggested** dominoes blocks electric car electric train marshmallow tongue depressor steel ball other objects chosen by the student	colored pencils	small shovel or garden trowel small pail or plastic container measuring cup dirt that contains rocks (.25 liter [1 cup]) glass container, tall clear (approx. size: .5 liter [2 cups]) flour (60 ml [1/4 cup]) water cake mix and items needed to make the cake nuts, gumdrops, chocolate chips, and/or M&Ms	baseball or similar hard-centered ball balloon water piece of string to tie balloon closed colored pencils **Optional** funnel

Experiment 17	Experiment 18	Experiment 19	Experiment 21	Experiment 22
2 liters (8 cups) or more of dirt suitable for making mud pies 1.75 liters (7 cups) or more of water 15 ml (1 Tbsp.) baking soda 15 ml (1 Tbsp.) vinegar measuring cup measuring spoon 3 containers for mixing mud (about 1.75 liter [7 cups] size) spoon or other implement for mixing mud garden trowel bucket paper marking pen pencil colored pencils	clear night sky colored pencils **Note:** This experiment will take 6 days to complete.	basketball ping-pong ball flashlight empty toilet paper tube glue or tape scissors marking pen a dark room	8 styrofoam balls: 1 - 10 cm (4 in) 1 - 7.5 cm (3 in) 2 - 5 cm (2 in) 2 - 4 cm (1½ in) 2 - 2.5 cm (1 in) water-based craft paint: red, blue, green, orange, brown paintbrush water in a container misc. objects to represent planets (such as fruits, vegetables, candies, baking mixes) for *Just For Fun* section	ladybug or other small insect or animal to observe magnifying glass Just For Fun section: a second living thing or an object to observe

Experiment 20
colored pencils night sky **Note:** This experiment will take two weeks to complete.

Materials

Quantities Needed for All Experiments

Equipment	Foods	Foods (continued)
bucket container, glass, tall, clear (approx. size: .5 liter [2 cups]) containers for mixing mud (about 1.75 liter [7 cups] size), 3 cups or small bowls (several) Experiment 13 suggestions: dominoes, blocks, electric car, electric train, tongue depressor, steel ball, other objects flashlight fork garden hose or funnel glass container, tall clear (approx .5 liter [2 cups]) Legos magnifying glass measuring cup measuring spoons pail (small) or plastic container pliers scissors shovel (small) or garden trowel spoon spoon or other implement for mixing mud trowel, garden	apple (2) baking soda (118 ml [8 Tbs]) or more banana (1-2) beans (several) cabbage, red (one head) cake mix and items needed to make the cake nuts, gumdrops, chocolate chips, and/or M&Ms to go in cake (see Experiment 16, Just For Fun) candy, color-coated such as M&Ms (several pieces) cheese (1 piece) crackers (1 or more) Experiment 9 Just For Fun suggestions: food items such as honey, berries, chopped fruit or vegetables, spices, herbs, cocoa, chocolate chips, etc. Experiment 21 Just For Fun: miscellaneous objects to use to represent planets (such as fruits, vegetables, candies, baking mixes, etc.) food items chosen by students	flour (60 ml [¼ cup]) food items chosen by students lemon or lime (1) lemon juice (180 ml [¾ cup]) marshmallows, large (1 pkg) marshmallows, small (1 pkg) milk (480 ml [2 cups]) orange (1) sugar, small quantity vinegar (180 ml [¾ cup]) or more water, tap yogurt, plain (.5 liter [2 cups])

Materials

Quantities Needed for All Experiments

Materials	Materials (continued)	Other
ball, ping-pong ball, rubber ball, tennis (2) balloon baseball or similar hard-centered ball basketball cardboard (stiff) or board (approx .3 meter x 1 meter [1 foot x 3 feet]) cotton balls (several) cups, clear plastic, 12 or more dirt, for mud pies (2 liters [8 cups]) or more dirt that contains rocks (.25 liter [1 cup]) feather (optional) glue or tape jar top, shallow marbles (2) misc. objects to be sorted into categories (see Exper. 7) paint, water-based craft: red blue green orange brown paints, watercolor paintbrush paper, several sheets paper to paint on, several sheets	pen, marking pencil pencils, colored pennies (optional) plastic bag, small playing cards (3) rocks (several) rubber bands string, 1 piece styrofoam balls (8): 1 - 10 cm (4 inch) ball 1 - 7.5 cm (3 inch) ball 2 - 5 cm (2 inch) balls 2 - 4 cm (1½ in) balls 2 - 2.5 cm (1 in) balls substances to test for acidity-basicity (see Exper. 5 Just For Fun) tape toilet paper tube, empty toothpicks, 1 box toy car water water in a container (to use with paints)	dark room internet access and/or reference books ladybug or other small insect or animal to observe living things to observe, such as an ant, frog, bird, cat, plant, or dog night sky, any night sky, clear non-living object to observe, such as a rock or piece of wood

Contents

Experiment 3

What Is It Made Of?

Materials Needed

- magnifying glass
- household items such as:
  - cotton balls
  - rubber bands
  - pencil
- several food items such as:
  - crackers
  - cheese
  - marshmallow
  - beans
  - color-coated candy (such as M&Ms)

Objectives

In this experiment students will learn how to make good observations.

The objectives of this lesson are:

- To have younger students make careful observations by noticing details.
- To help students develop a vocabulary to describe their observations.

Experiment

I. Think About It

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

Here the students will think about and describe the features of objects such as a cracker, a piece of cheese, a piece of candy. **Without allowing the students to look at the object**, name the object and have the students describe it, using both words and pictures. (They will observe the actual object in the following section.)

Direct their inquiry with questions. For example:

- *What color is a cracker?*
- *Is a cracker hard (like a plastic toy) or soft (like a feather)?*
- *Is a cracker large (like an elephant) or small (like a mouse)?*
- *Is a cracker smooth (like a marble) or rough (like sandpaper)?*
- *If you break a cracker, does it look the same on the inside as the outside?*

Using a cracker as an example, the students' answers may look something like the following example.

(Answers may vary.)

Write down the name of an object. Using words and drawings, describe any features you think it has.

cracker

brown	*round*	*scratchy*	*crumbly*

II. Observe It

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

Have the students look carefully at the object you've provided for them. Using the magnifying glass, have them examine the object and make careful observations about it. Ask them if the object looks different from what they thought it would.

Direct their investigation with questions such as the following, again using the cracker as an example.

- *Is the cracker as large (or as small) as you thought it would be?*
- *Is the cracker smooth or rough?*
- *What color is the cracker? Is it exactly brown (or white)? Does it have other colors in it?*
- *What happens to the cracker if you break it in half? Is it the same on the inside as on the outside?*
- *What does the cracker look like under the magnifying glass? Can you describe what you see?*

Often students discover that they have not seen or thought about some detail of a familiar object. For example, sometimes crackers have holes on the top. This may be a detail they have never noticed. Or there may be stripes or speckles in the cracker that they haven't observed before. Also, they can observe that some objects are the same on the inside as they are on the outside, like cheese and cotton balls, but other things are not the same on the inside and the outside, like color-coated candy or beans.

For this part of the experiment (using the cracker as an example), the students' answers may look something like this:

(Answers may vary.)

Write down the name of the object you thought about. Describe what you actually see, using words and drawings.

cracker

white and brown speckles	*holes on top*	*rough inside*	*seeds*

Have the students repeat this exercise with two or three more objects, first describing the item in the *Think About It* section without looking at the object and then using the *Observe It* section to record what they actually see. They can observe as many items as they want to, describing the item first without looking at it, and then carefully observing the item with a magnifying glass. They may want to choose their own items to observe.

III. What Did You Discover?

Read the questions with your students.

❶-❻ The questions in this section of the *Laboratory Notebook* can be answered verbally or in writing, depending on the writing ability of the students. Help the students think about their observations as they answer these questions. Have the students compare their list of descriptions of each object before and after they looked at it, and help them notice where an observation was the same as what they expected to see and where an observation differed from their expectations.

IV. Why?

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

Have a discussion with the students about why their observations may have been different from what they thought they would see.

V. Just For Fun

Have the students choose a person to compare to themselves. They may want to choose someone who is in the room so they can look at that person as they do this part of the experiment.

Guide the students in making observations about what is similar and different between themselves and the other person. Encourage the students to notice details, and have them record their observations. The students' answers will be based on what they actually observe, and there are no right answers to this experiment.

Experiment 7

Where Does It Go?

Materials Needed

- cotton balls
- rubber ball
- tennis ball
- banana
- apple
- rocks
- Legos
- other objects
- colored pencils

Objectives

In this experiment the students will try to sort objects into different groups according to their characteristics.

The objectives of this lesson are:

- To help students understand that there are different ways to sort objects.
- To have students develop a vocabulary to describe the objects they observe.

Experiment

I. Observe It

In this section the students will make careful observations for each of the objects they have collected.

Read this section of the L*aboratory Notebook* with your students.

❶ Help the students collect objects to observe.

❷ Put the objects on a table and have the students look carefully at each item.

Help them observe different details such as size, color, shape, and texture for each item. Use questions to help them describe the object.

- *What color is a cotton ball?*
- *What color is a banana?*
- *What is the shape of a cotton ball?*
- *What is the shape of a rock?*
- *How would you describe the surface of a tennis ball?*

❸ Encourage students to use both words and pictures to describe each object. Have them use as many different describing words as possible for each item. Their answers may look something like this:

(Answers will vary.)

cotton ball

fuzzy *round* *soft* *white*

tennis ball

fuzzy *round* *hard* *yellow*

(Answers will vary.)

rock

hard	*gray*	*smooth*	*heavy*

building block

square	*hard*	*blue*	*plastic*

II. Think About It

Read this section of the L*aboratory Notebook* with your students.

❶ Have the students look at the different objects and the different ways they have described the objects. Help them think about how they might group the objects according to their descriptions.

❷ Have the students think of five different groups and then write the names of the groups in the gray boxes. Next, have them sort the objects they have collected into the different groups. Each object can only go into **ONE** group.

Their answers may look something like this:

(Answers will vary.)

round	*yellow*	*small*	*hard*	*white*
tennis ball	*banana*	*rock*	*block*	*cotton ball*
	apple		*rubber ball*	

❸-❹ Help the students notice that some items can fit into more than one group. For example, if they chose the groups round and yellow, a tennis ball can fit into both groups. Have the students think about how they might rearrange the groups, picking different items that go into each group. They can re-sort their items into the groups they've already chosen, or they can pick new groups.

Help them notice features that are similar and different between the objects by asking questions such as:

- *Is a rubber ball larger or smaller than a cotton ball?*
- *Is a rubber ball harder or softer than a cotton ball?*
- *Is a rock like a banana? Why or why not?*
- *Is a tennis ball similar to a banana? Why or why not?*

There are no "right" answers, so encourage the students to think about all the different ways they may want to sort the items.

III. What Did You Discover?

Read the questions with your students.

❶-❹ The questions can be answered verbally or in writing, depending on the writing ability of the student. With these questions, help the students think about their observations. Again, there are no "right" answers to these questions, and it is important for the students to write or discuss what they actually observed.

IV. Why?

Read this section of the L*aboratory Notebook* with your students.

It is important for students to understand that science is often a dynamic endeavor, and the "answers" that science provides can sometimes change. The identification and grouping of living things can be fairly complicated, and determining exactly which group a living thing belongs to is not trivial. There are different criteria used to group living things. Most living things are first grouped according to the types of cells they have — plant cells, animal cells, bacterial cells, etc. Once the organism is grouped according to cell type, then the scientist looks for other features to use in categorizing the organism.

V. Just For Fun

Read this section of the L*aboratory Notebook* with your students.

Help the students think about how they would categorize the new creature according to the features and groups given. There are no right or wrong answers in this section.

Encourage students to use their imagination in creating this new creature.

Experiment 19

Earth in Space

Materials Needed

- basketball
- ping-pong ball
- flashlight
- empty toilet paper tube
- glue or tape
- scissors
- marking pen
- a dark room

Objectives

In this experiment students will use simple materials to explore how light from the Sun affects the Earth and the Moon.

The objectives of this lesson are:

- To have the students observe how the Sun illuminates the Earth and the Moon.
- To demonstrate lunar and solar eclipses and the seasons.

Experiment

I. Observe It

In this section students will make a model Earth and use it to explore the illumination of the Earth and the Moon by the Sun.

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

❶-❷ Here the students will make a model of the Earth. Help them cut out the continents from the page and paste or tape them on the basketball in the appropriate positions, with North America, South America, and Greenland on one side; and Australia, Africa, Europe, Russia, and Asia on the other side. Have students refer to a globe if needed.

Have the students mark the approximate location of the North and South Poles by taping or gluing small pieces of paper to the basketball or by using a marking pen.

❸ Help your students cut the toilet paper cylinder 2.5 cm (one inch) from the end. This will create a ring to hold the basketball. Have them place the basketball on the ring and slightly tilt the ball so the North Pole is pointed slightly to the side. This represents the tilt of Earth's axis which is about 23° from vertical.

❹ A flashlight will be used to model the Sun. Have the students turn off the room lights and shine the flashlight on the basketball from some distance away. Have them observe how the flashlight illuminates the basketball.

❺ Students can place the flashlight on the floor, or you can hold the flashlight for them. They will now slowly rotate the basketball in a counterclockwise direction to simulate the rotation of Earth on its axis.

Guide your students' inquiry with the following questions:

- *Does the light cover the whole basketball or just one side?*
  just one side
- *If the light is shining on Asia, is North America light or dark?*
  dark
- *As you rotate the ball, does the light on Asia stay the same?*
  No, it changes.
- *Are Asia and Russia illuminated at the same time?*
  yes
- *Are Asia and North America illuminated at the same time?*
  no
- *If it is light in Asia, do you think it will be day or night in Russia?*
  day
- *If it is dark in Asia, do you think it will be day or night in North America?*
  day
- *Do you think that if the light is shining on South America it will be day or night in North America?*
  day

Have the students record their observations.

❻ Now the students will model the Moon. Have your students take the ping-pong ball and place it between the basketball and the flashlight, some distance away from the basketball. They will have to hold the ping-pong ball with their fingers. Have them observe the shadow the ping-pong ball casts on the basketball when it is between the basketball and the flashlight. This represents a solar eclipse during which the Moon blocks sunlight from reaching a portion of the Earth.

Have your students move the ping-pong ball in a circle around the basketball. As the ping-pong ball goes behind the basketball, the basketball casts a shadow on the ping-pong ball. This represents a lunar eclipse when Earth's shadow falls on the Moon.

Guide student inquiry with the following questions:

- *What happens to the basketball when the ping-pong ball is between the flashlight and the basketball?*
  [This represents the Moon between the Sun and the Earth—a solar eclipse.]
  The basketball will have a round shadow on it created by the ping-pong ball.
- *What happens when the basketball is between the flashlight and the ping-pong ball?*
  [This represents the Earth between the Sun and the Moon—a lunar eclipse.]
  The ping-pong ball is in the shadow created by the basketball.

Have the students record their observations.

II. Think About It

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

❶-❸ Have the students answer the questions. Encourage them to answer in their own words. Suggested answers are shown below.

(Answers may vary.)

❶ Can you determine how day and night are created by the rotation of Earth?

As the Earth rotates, the Sun shines on different parts of the globe.

❷ Can you observe how a lunar eclipse forms (where Earth casts a shadow on the Moon)?

When the Earth blocks the Sun's light from the Moon, the Moon has a shadow on it from the Earth.

❸ Can you observe how a solar eclipse forms (where the Moon casts a shadow on Earth)?

When the Moon blocks the Sun's light from the Earth, the Moon's shadow falls on the Earth.

❹ *Using the basketball and flashlight, can you show how the seasons are created? Explain how you would do this.*

Help your students model how the orbiting of Earth around the Sun creates seasons. Have the students stand some distance away from the flashlight Sun, holding the basketball Earth and tilting it slightly as it was in the *Observe It* section. One pole should be pointed toward the flashlight. Students will need to keep the tilt of the basketball constant as they circle the flashlight.

Have them hold the basketball and walk around the flashlight in a counterclockwise direction. To simulate the orbit of Earth around the Sun, students will remain facing in the same direction as they circle the flashlight. With the flashlight on their left and the "pole" of the basketball pointing toward it, they will start walking forward, then to the left, then backward, to the right, and forward again, completing the circle. Have them notice how one pole is tilted toward the Sun on one side of the circle and the other pole is tilted toward the Sun on the opposite side of the circle.

Discuss with the students how the parts of the Earth that are tilted toward the Sun receive more heat energy from the Sun and the parts tilted away receive less. At different times of the year different parts of the Earth are tilted more toward the Sun.

III. What Did You Discover?

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

❶-❹ Discuss the questions in this section with the students. Have them record their answers. Since these answers are based on what the students actually observed, their answers may vary.

IV. Why?

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

Review with the students how in this experiment they used a flashlight to represent the Sun, a basketball for Earth, and a ping-pong ball for the Moon. Explain that by doing this they built a model and that scientists build models to help them understand how things work. With this model the students were able to explore how the Earth rotates, creating day and night; how the movements and positions of the Moon and Earth create lunar and solar eclipses; and how seasons occur. (Students will learn more about making models in a following experiment.)

V. Just For Fun

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

Help the students look at the map on the basketball and mark the approximate location of where they live and the location of the equator. Help them orient the basketball and flashlight for each part of this experiment.

Encourage students to use their imagination as they experiment with the ideas presented in this section.

There are no right answers here. The purpose of this exercise is to encourage students to make observations, explore ideas, and use their imagination.