Welcome to Science B!

In this program, your students will measure the sunlight in a day, explore the phases of the Moon, develop ways to improve their hearing, build the best sail, and so much more.

The 36 experiments in this program will introduce your students to Light and Sound Waves, Biological Features, Space Systems, and Engineering Design. They are designed to teach your students to think like scientists and use real scientific skills and practices.

What do Students Need to Know?

In the past, science instruction focused on teaching students what we already knew about science. However, as technological growth and development exploded in recent years, we realized that simply teaching students what we know now isn't sufficient—it doesn't adequately prepare them for the future. The technology and scientific developments our students will use when they are adults haven't been invented yet. So how do we prepare them for what they will need to know when it is still unknown to us?

Instead of teaching facts and knowledge, our instructional focus needs to shift. In addition to exposure to familiar science topics, such as Physical Science, Life Science, and Earth and Space Science, today's students also need skills, and scientific practices, that will help them find out what they need to know on their own. They need to become innovators and developers and not just passive consumers of scientific knowledge. By the time your students are ready for further education or to enter the workforce, they need to know how to investigate purposefully, build models, ask useful questions, and be able to report their findings so they can share what they learn with others. They should also be able to develop creative solutions to problems, and build and test their designs to determine how well they work. Once tested, they should be able to improve their designs so they can develop an even better solution. The lessons required to arrive at this destination will need to be hands-on, interactive, and student-driven. They may be a little noisy, and hopefully not too messy, but certainly an adventure like no other.

Introduction

How This Program Works

Through this program, your students will use the Scientific Method to explore their world, not just memorize the steps. Your students will brainstorm solutions to problems, and have space to come up with ways to test them with you. Together, we will begin to prepare them to think for themselves, weigh the claims they encounter around them, and innovate on their own. We will also incorporate key Scientific and Engineering Practices to explore ideas that connect across all subjects, like cause and effect, patterns, structure and function, systems, stability and change, cycles, and more.

In addition to practicing the Scientific Method, you will also begin to teach the process of Engineering Design, in which students investigate a problem they can solve through design. Some lessons will present a challenge or problem which will require your students to design (and build!) a solution, and then they will test their solution's effectiveness in solving the problem. From there, they may also apply what they learned from their tests toward designing an improved solution.

Science B will serve as your roadmap for this year's experiment instruction. We have chosen easy experiments that will fascinate your students and help them begin to develop key scientific skills through exploration. Before you start teaching, take a few minutes to familiarize yourself with this book and the structure of each experiment.

Each lesson begins with an overview of the **Key Concepts**, intended to give you, the instructor, a big-picture view of the goals of the lesson. By the end of the experiment and discussion, your students should have a solid understanding of the lesson's Takeaways (which mirror the Key Concepts), so you know they have mastered the important information. And since each lesson is truly an exploration, your students will often delve into elements of several different scientific disciplines in a single day.

Introduction

Let's Get Started

To help you teach with confidence, we recommend you read through each experiment the night before. You may also use this time to gather the supplies noted on the Materials List that you will need to provide. While you will find some experiment supplies around your home, we have collected a number of materials for your convenience in our **Science Supplies Kit**, listed with a K in the Materials List (at the beginning of each experiment). The data charts and templates, listed with a P, follow each experiment and are also included in the **Paper Packet**.

The **Appendix** of this book includes a complete list of the supplies you will need to provide yourself, a list of items in the Science Supplies Kit, and a list of charts and templates in the Paper Packet. You can start collecting the items you need to provide now so they will be ready when you need them.

A few of the experiments require some early preparation, which we'll warn you about in a **Before You Begin** note at the start of the experiment. Be sure to check the next experiment for this note when you wrap up an experiment so you will be fully prepared to teach the next lesson when you intend to.

When you have gathered the supplies and are ready to teach, head to the experiment's **Introduction** and simply start reading to your students. Our provided instruction helps you pique your students' curiosity about each day's topic, and will challenge them to **Make a Prediction** about what they will experience in the experiment. The **Investigate** section offers step-by-step procedures that walk you through the experiment itself, and includes discussion information to help you explain what's happening along the way. Use the questions under **Draw Conclusions** to bring the concepts and observations together, and close with the thoughts under **Takeaway**.

As you have time, enjoy the information under **See the Bigger Picture** which illustrates how the scientific principles discussed in the lesson apply to the world at large. Also, be sure to check out the **Make Connections** section as you work to add more depth and extend conversation about the experiment's topic. We also include **Tips** to help you know what to expect and complete the investigations with as few bumps as possible. If your students still want more, try out the suggestions under **Go Further** for related activities that will help you extend the exploration.

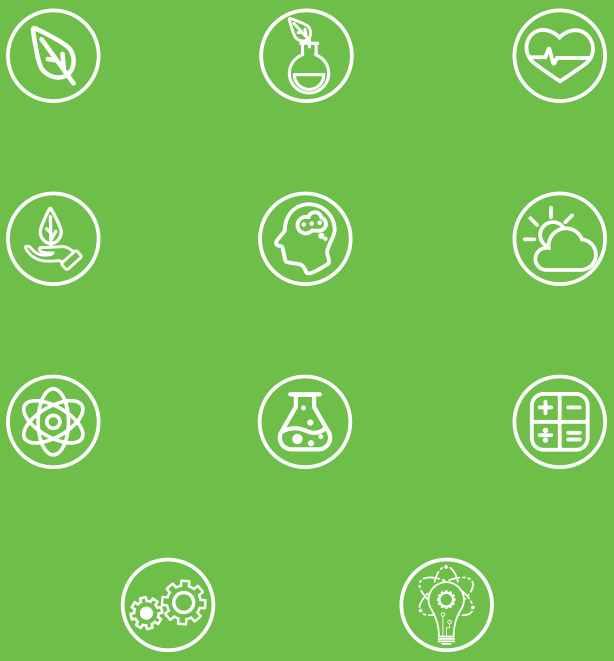
Introduction

Plan for your students to take an active role in setting up the experiment and completing the steps (with your help, of course). Give them room to be curious and ask questions. If we don't address something that comes up as you work by the end of the experiment, make a note to help them find the answer later. The more you can support their curiosity and inquisitiveness, the better you will teach them to think like a scientist. And don't forget—they can help you clean up, too!

You are Ready to Begin!

We can't wait for you to start this grand adventure with your students, helping them to explore their world while learning to think like scientists and design like engineers. Through this journey, you will prepare them to be an active part of a future that we can't even imagine today.

Experiments



1 What Makes Day and Night?

Key Concepts

Patterns of the motion of the sun in the sky can be observed, described, and predicted. The sun's path across the sky to create day and night follow these predictable patterns.

The sun seems to disappear at night. It is hidden because the earth spins on its axis. When it is not visible to people in one location on earth, it is visible to the people on the other side of the world.

We can see better when the sun illuminates our part of the earth.

Before You Begin

This lesson works best when the student completes three to four days of observations before completing the rest of the activity. We suggest reading the Introduction and beginning Part 1, "Begin Sun Movement Observations," early in the week, then completing "Analyze the Data" and the rest of the lesson later in the week.

Materials

- Styrofoam ball K
- wooden skewer K
- rubber band K
- plastic thumbtack K
- flashlight K
- chalk (optional) K
- What Makes Day and Night? Experiment Sheet P
- Cardinal Direction Labels P
- Observation Notebook P
  Sun Movement pages
- sandwich-sized clear plastic bag
- twist tie
- yellow, orange, and red crayons or markers

K Indicates the item is in the Supply Kit.

P Indicates the item is in the Experiments Paper Packet.

Introduction

What is a pattern? A **pattern** is a set of things that repeat. Sometimes, you can find patterns in a series of colors or shapes that repeat. You can find patterns in tile floors, fabrics, and wallpaper. In music, we enjoy patterns of notes that repeat to make our favorite tune. Patterns are everywhere.

We find patterns in nature, too. What types of patterns have you observed in nature? (Possible: Flowers that look the same grow from the same type of seed; an apple tree always grows apples; leaves on one tree always grow in the same shape, etc.)

Do you think the sun and the moon make patterns? You have probably observed some of their patterns already.

Every morning, the sun rises over the **horizon**. When the sun comes up, it is daytime. Every evening, the sun sets. When the sun goes down, night falls and it gets dark. The sun rises and sets every day. It follows a pattern. The sun appears to move. During the day, it seems to march across the sky. Ancient people once thought that the sun travels around the earth. But does it?

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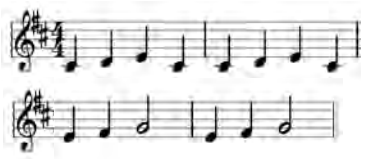
Patterns



...in music...

...in art...

...in nature.

The **horizon** is the line where the land seems to meet the sky.

1

Data are bits of information you collect to help you explore and understand the world.

Today, you will begin to observe the sun. When scientists observe, they collect and record **data** about their observations. The data help them find patterns in what they observed. Like scientists, you will record data about your observations of the sun, and later look for patterns in the data. You will try to identify patterns in the way the sun seems to move.

Make a Prediction

Why is the sun out during the day and gone at night? Does the sun move, or there is another explanation to why it's light in the day and dark at night? Record your predictions in the space provided on the **What Makes Day and Night? Experiment Sheet**.

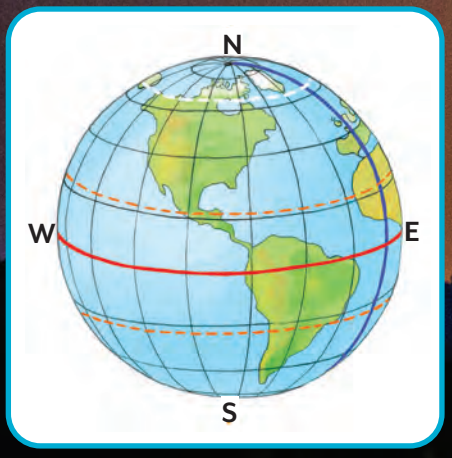
Investigate

Begin Sun Movement Observations

We know the sun comes up in the morning and sets in the evening. But what does the sun do all day? If it seems to move, how does it move? Does the way it appears to move follow any patterns? Let's begin some observations to find out.

Before you begin your observations, let's talk about the **cardinal directions** north, east, south, and west.

What do you know about the directions north, south, east, and west? Can you identify any of these directions? (Answers will vary. Teacher: Guide the students to identify the four directions, reinforcing the idea that north is always north and never changes positions, whereas if two people pointed to their left, they could be pointing in different directions.)



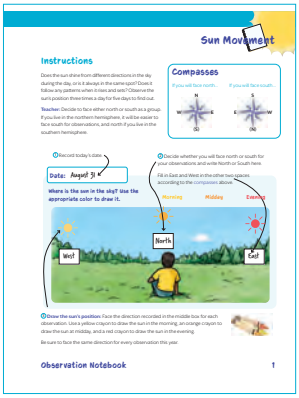
A compass rose is a star-like symbol surrounded by the letters N, E, S and W to represent "north," "east," "south" and "west." On a globe, north is at the top and south is at the bottom. On maps, "up" is usually north—the compass rose will tell you for sure.

For the next four days, you will observe and record the sun's position in the sky in the morning, at midday, and in the evening. Is the sun in the same part of the sky at the same time of day? The observations you record will help you answer this question.

To help you record observations that could show a pattern, your observations need to be consistent. You will need to always face the same cardinal direction—either north or south—and then find the sun. You will then draw the sun's position in a diagram.

1. Use the **Cardinal Direction Labels** to label the four walls in your school room north, south, east and west. If going outside, bring the labels or use sidewalk chalk to mark directions on the concrete.

2. Find the **Observation Notebook** in your Paper Packet. Find the section on Sun Movement. The first page of the Sun Movement section explains how to record observations.

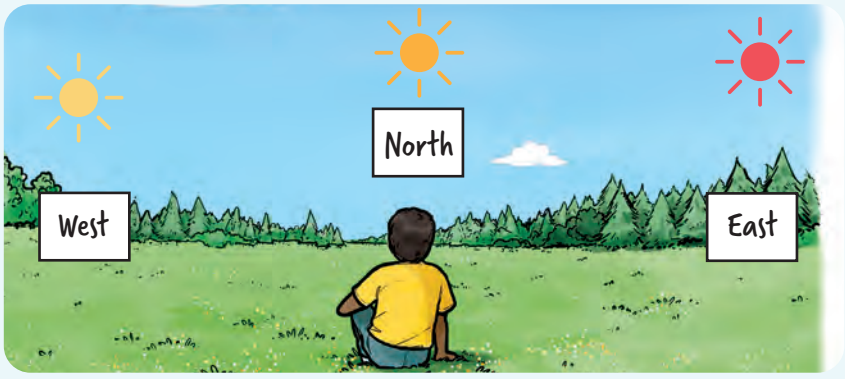


3. Record observations three times a day for three to four days.

Analyze the Data

Once you've completed your observations, let's review the data you collected and look for patterns.

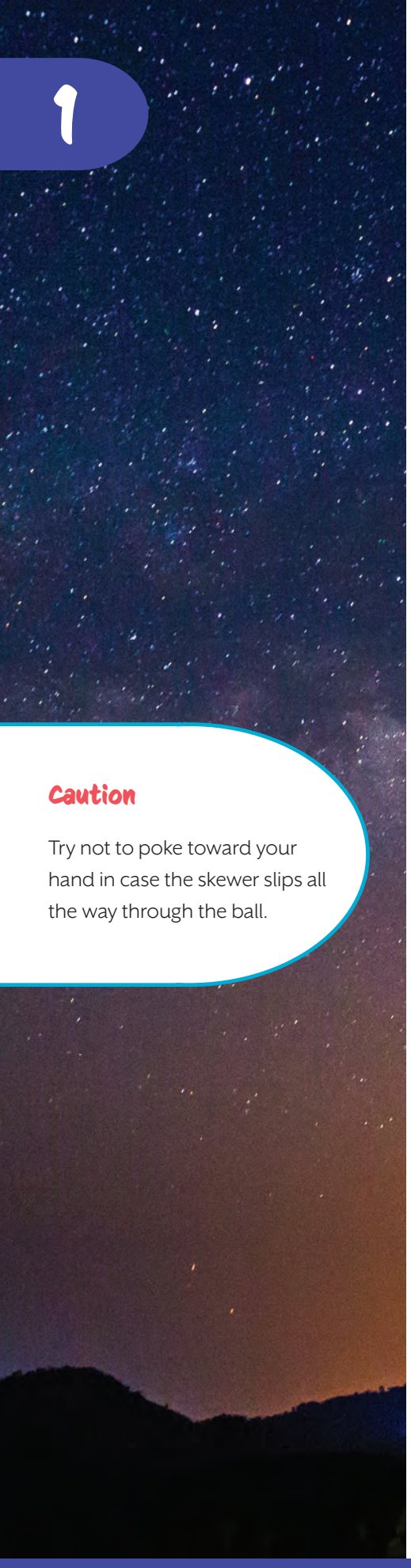
Is there a pattern in the colored suns you drew in the diagrams? Compare a couple of diagrams against each other. (They do make a pattern. Yellow is always on one side, orange in the center, and red on the other side.)



The suns' colors make a pattern in the diagrams. So, because the colors make a pattern in the diagrams, that means the sun also makes a pattern in the sky during the day.

Teacher

Remind your students that they should never look directly into the sun, as the bright light can cause eye damage.



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In which direction do you find the morning sun? And the evening sun? (Morning sun is in the east; evening sun is in the west.)

The sun always rises in the east and sets in the west. At midday, it is directly overhead. So, does this pattern mean the sun moves?

What Causes Daytime and Nighttime?

Let's make a model to explore the way the sun and the earth work together to make day and night.

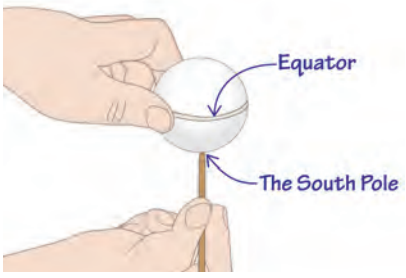
A **model** is a smaller version that can represent something real, but is easier to move around, study, or manipulate. We'll use a light to serve as a model of the sun and a ball for the earth. We will use our model to help us understand why day and night occur.

Caution

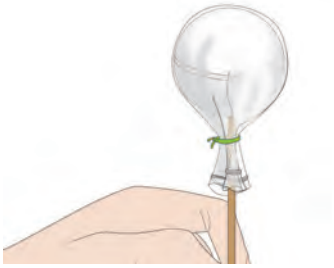
Try not to poke toward your hand in case the skewer slips all the way through the ball.

1. Stretch a rubber band around the center of a Styrofoam ball to represent the **equator**.

2. Carefully poke the sharp end of a skewer into the center of the Styrofoam ball so that the ball sits on the skewer without moving. The equator should be perpendicular to the skewer, which represents the South Pole.

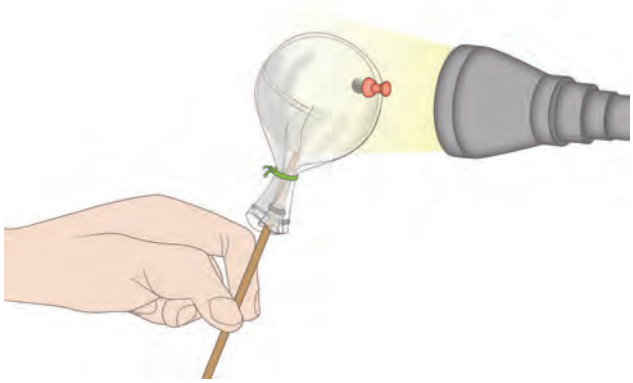


3. Slip a plastic sandwich bag over the Styrofoam ball, and secure it with a twist tie. You will draw on the bag in a later. experiment.



4. Place a thumbtack to represent where you live. If you live in the northern **hemisphere**, put one above the band. If you live in the southern hemisphere, place it below.

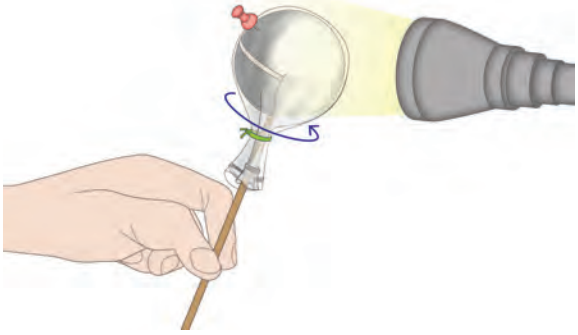
5. Shine a flashlight so that the light hits the thumbtack on the Styrofoam ball.



The flashlight represents the sun and the Styrofoam ball represents the earth. Right now, the sun's light is shining on the tack.

If you were standing on the thumbtack, would it be day or night? (It would be day because the thumbtack is in the light.)

6. Twist the skewer so that the thumbtack on the Styrofoam ball is facing away from the flashlight sun.



The earth rotates, or spins, around its **axis**. An axis is the imaginary line that goes from the North Pole to the South Pole, which the earth spins around. You made the earth rotate by twisting the skewer, which is the Styrofoam ball's axis. Now the tack is away from the sun.

If you were standing on the thumbtack, would it be day or night? (It would be night because the thumbtack is in the dark.)

Did You Know?

The **equator** is an invisible line scientists draw that wraps around Earth's middle like a belt.

A **sphere** is a ball shape. The word **hemisphere** simply means "half of a ball" shape. Earth is divided into the Northern Hemisphere and Southern Hemisphere at the equator.

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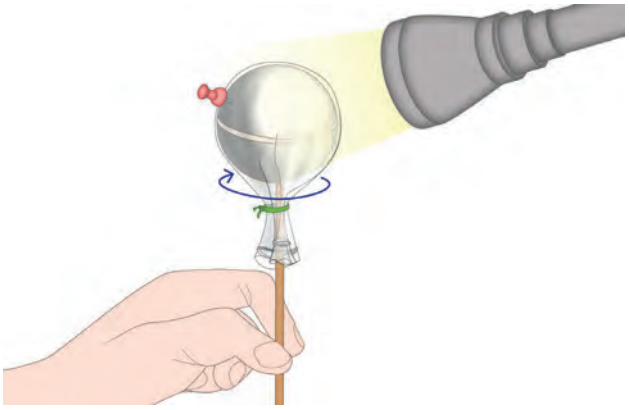
Is the flashlight sun still shining? (Yes)

If you were standing on the thumbtack, would you be able to see the flashlight sun shining? Why? (No, because the flashlight sun is on the other side of the earth.)

7. Twist the skewer so that the flashlight sun hits the side of the thumbtack.



Compare the light near the thumbtack to the brightest part of the light on the ball and the darkest area on the ball. If you were standing on the thumbtack, how light or dark would it be? What time of day do you think this represents? (It is not as bright as the brightest part, and not as dark as the darkest part. This is like sunrise or sunset, early morning or late evening.)

8. On the **Experiment Sheet**, draw a picture to show the position of the ball, tack, and light when it is daytime for the thumbtack and another picture to show their positions when it is nighttime for the thumbtack.

Each day, the earth spins around once. It takes 24 hours for the earth to make one complete rotation. As it spins, different parts face the sun. It is daytime for the parts of the earth that face the sun. It is nighttime for the parts of the earth that face away from the sun because the earth blocks the sunlight from shining on the other side of the earth. The sun doesn't move around the earth, instead, the earth's rotation causes the sun to rise and set based on the view from our part of the earth.

Did You Know?

The earth rotates at roughly 1000 miles per hour. However, because it is so big (24,859.734 miles all the way around, to be exact), it takes 24 hours for it to turn all the way around once.

Draw Conclusions

What patterns does the sun make in the sky? (Possible: The sun rises in the morning and sets in the evening; the sun travels through the sky from east to west; the sun provides light during the day but not at night.)

What causes us to experience day and night? (The earth rotating, or spinning.)

Why is it dark at night? Where is the sun at night? (The earth spins and we move into the earth's shadow where the sun doesn't shine. The sun is shining on the other side of the earth.)

As the earth spins, different parts move into the light from the sun. The earth's turning movement makes the sun appear to rise and set. When our side of the earth turns away from the sun, its light no longer shines on us and our sky gets dark.

Takeaway

In this activity, we observed the sun's position in the sky at three different times of the day. Like scientists, you recorded data about where you saw the sun each day. After several days, you compared the data you collected to look for patterns. From your data, you could see that the sun always rises in the east, is overhead at midday, and sets in the west. With this information, you can now also predict where the sun will be in the sky based on the pattern you observed.

You modeled what causes day and night. The sun gives off its own light, which we see during the day, when our side of the earth faces the sun. The earth rotates around its axis, causing us to face away from the sun. When we do, the earth's shadow blocks our view of the sun and prevents sunlight from hitting our side of the earth, which is why nighttime is dark.

See the Bigger Picture

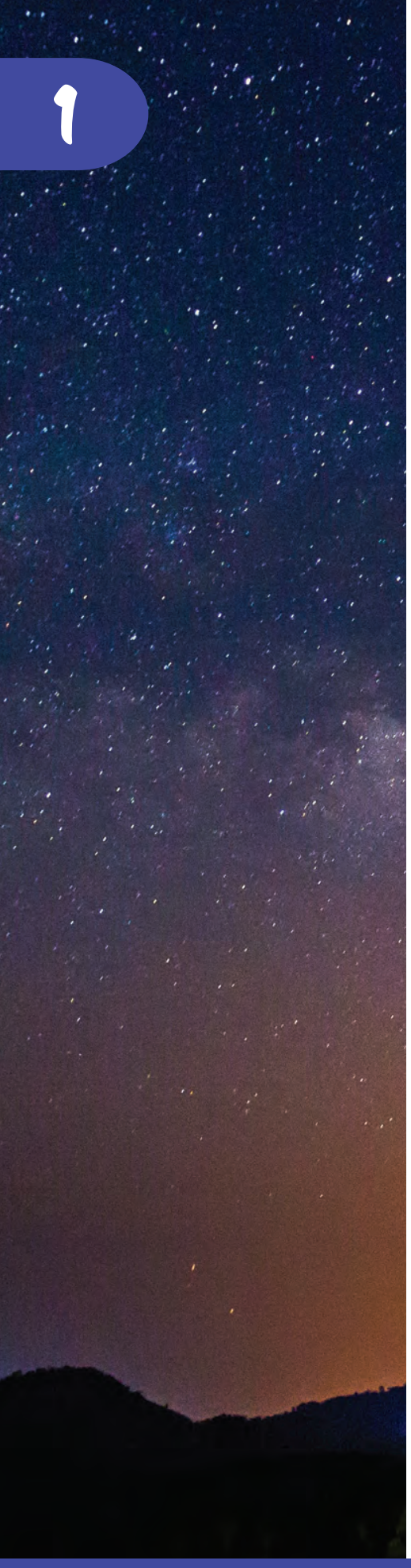
Why do cardinal directions matter? Cardinal directions help us understand maps and travel from place to place successfully because they provide a way to talk about directions in the same way. For example, let's say you want to tell a friend about a new park you visited. You know

Important

Please save the Styrofoam ball, thumbtack, and skewer model of the earth you made today. You will use it again several times this year.

Did You Know?

We need light to see, so when the sun is on the other side of the earth, we use electric lights or fire to help us see at night. We can see objects that give off their own light in the dark, but need a light to shine on (or **illuminate**) objects that do not so we can see them.



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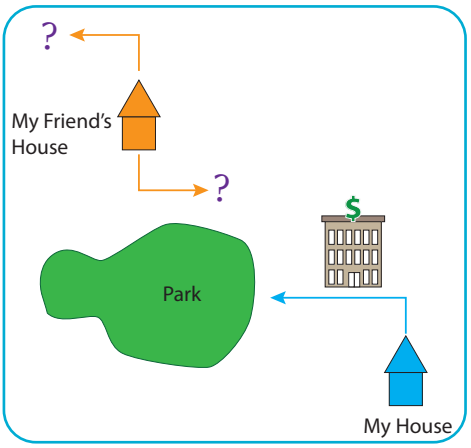
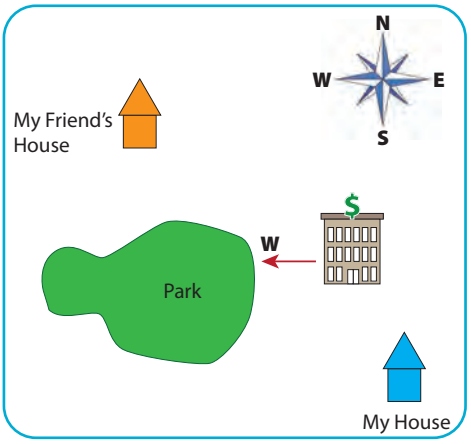
you turned left from your house to get there, but your friend lives in a different neighborhood. If you tell your friend they just need to turn left from their house, they would not end up in the same place because they started at a different point!

When you look at a map, cardinal directions help you understand how the places on the map relate to each other and to your position in real life. If you tell your friend the new park is west of the bank, they can head west from the bank and soon come to the park.





Go Further

Make a prediction. Tomorrow, where will the sun be in the sky in the morning? Midday? Evening? Write down your prediction in your Observation Notebook. Then, tomorrow, observe the sun and see if you are correct.

Try acting as the earth. Ask an adult to point the flashlight at your stomach so you can see the light on your shirt. Are you experiencing day or night? (It is day because you can see the light on your shirt.)

Turn around and face away from the sun, but continue to have the flashlight shine on you. Are you experiencing day or night? (It is night because you can't see any light on your shirt.)

The light from the flashlight never stopped giving off light, just like the sun never stops giving off light. We just can't always see the light of the sun because sometimes we are facing away from it.

Experiment Sheet 1

Make a Prediction

Why do we have light during the day and darkness at night?

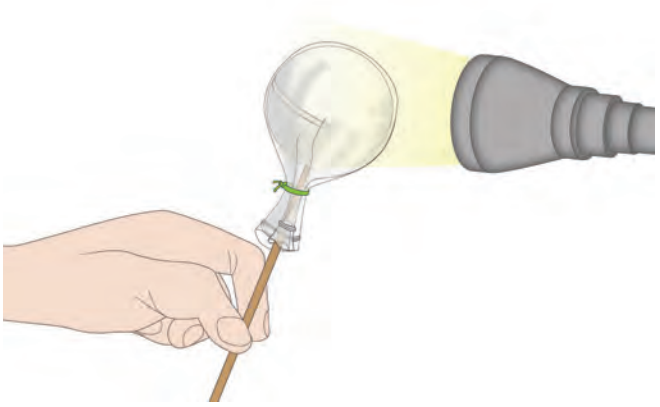
_____

_____

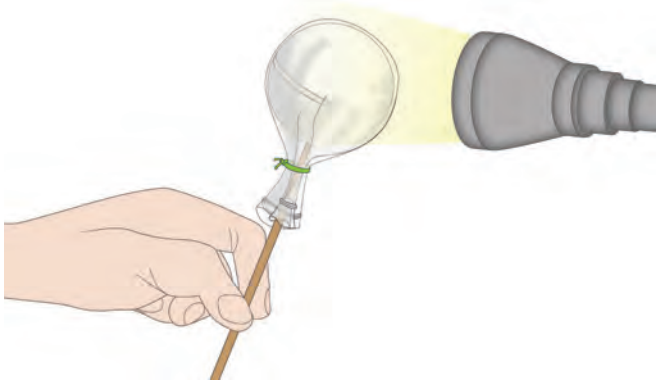
_____

What Causes Daytime and Nighttime on Earth?

Draw a tack to show what it looks like when it is daytime for the tack.



Draw a tack to show what it looks like when it is nighttime for the tack.



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north

east

south

west

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Sun Movement

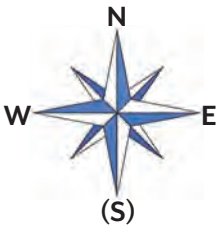
Instructions

Does the sun shine from different directions in the sky during the day, or is it always in the same spot? Does it follow any patterns when it rises and sets? Observe the sun's position three times a day for five days to find out.

Teacher: Decide to face either north or south as a group. If you live in the northern hemisphere, it will be easier to face south for observations, and north if you live in the southern hemisphere.

Compasses

If you will face north...



If you will face south...

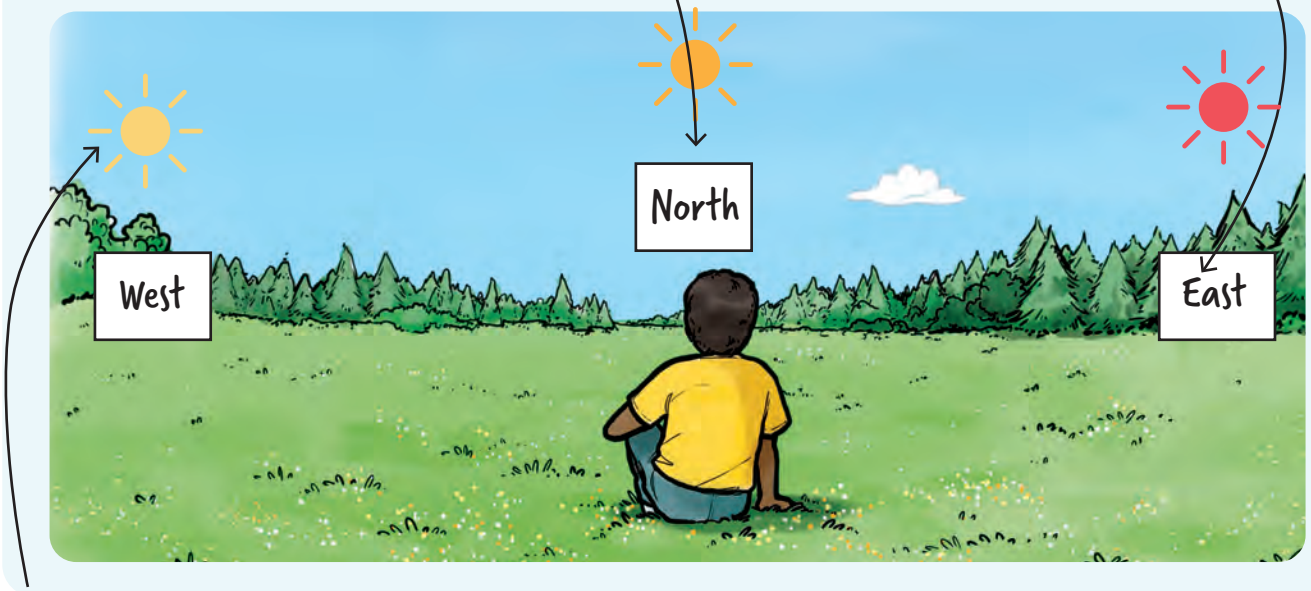
① Record today's date.

Date: August 31

② Decide whether you will face north or south for your observations and write North or South here.

Fill in East and West in the other two spaces according to the compasses above.

Where is the sun in the sky? Use the appropriate color to draw it.



③ **Draw the sun's position:** Face the direction recorded in the middle box for each observation. Use a yellow crayon to draw the sun in the morning, an orange crayon to draw the sun at midday, and a red crayon to draw the sun in the evening.

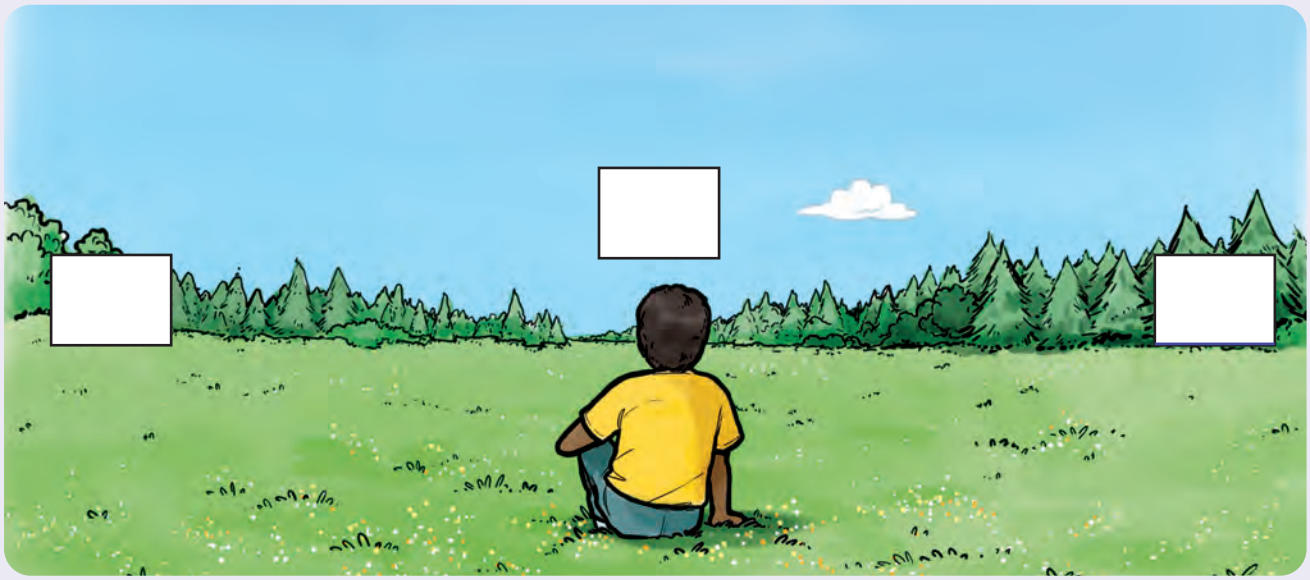
Be sure to face the same direction for every observation this year.

Sun Movement

Date:

Where is the sun in the sky? Use the appropriate color to draw it.

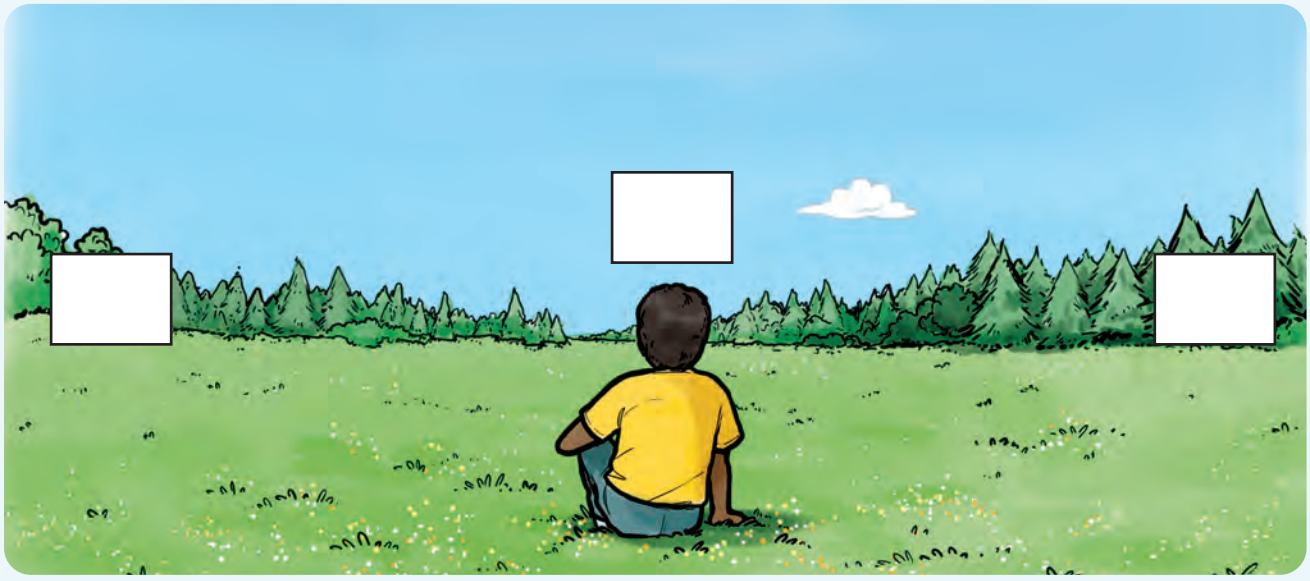
Morning Midday Evening



Date:

Where is the sun in the sky? Use the appropriate color to draw it.

Morning Midday Evening

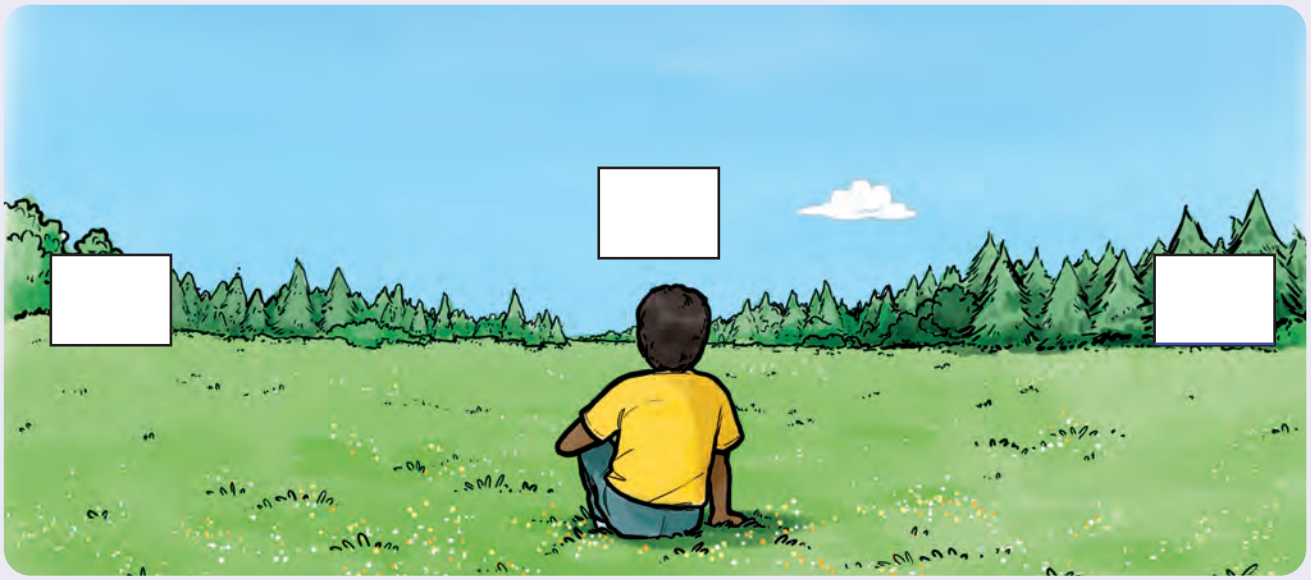


Sun Movement

Date:

Where is the sun in the sky? Use the appropriate color to draw it.

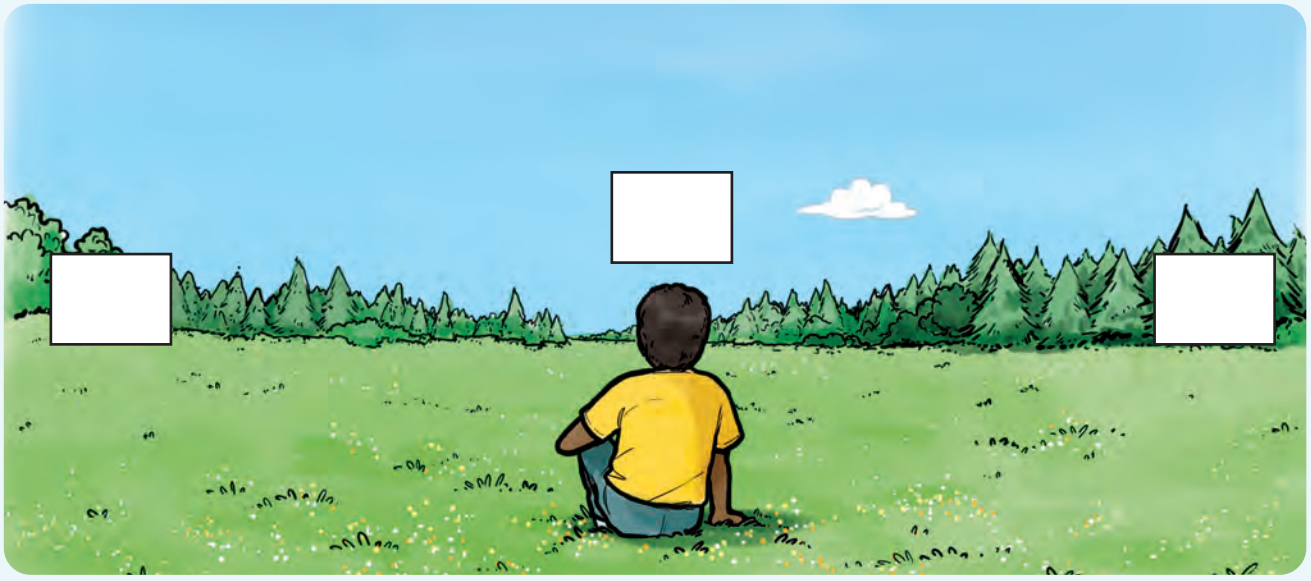
Morning Midday Evening



Date:

Where is the sun in the sky? Use the appropriate color to draw it.

Morning Midday Evening



Sun Movement

Go Further (Optional)

Date:

Where will the sun in the sky tomorrow? Use the appropriate color to draw your prediction.

Morning Midday Evening