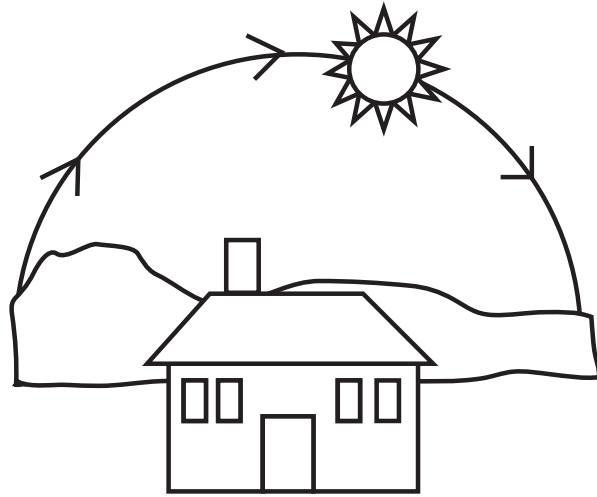


Lesson 3

Watching the Sun for a Day



Big Idea

The sun appears to travel through the sky in a predictable daily pattern.

A QUICK LOOK

Overview

Children observe the sun several times throughout the day and discern how it seems to move across the sky. In addition, they learn about the variables, such as landmarks and shadows, needed to make accurate observations of the sun. Later lessons in this cluster have the children consider that a rotating Earth and a stationary sun make the sun appear to move across the sky.

Key Notes

- By the end of this lesson children should demonstrably understand the Big Idea. For children who do not, provide extra time in the Science Center to practice manipulating light, objects, and shadows.
- This lesson requires a clear day during which the sun is visible. A minimum of three observations is needed, so do this lesson in one day or over several days (at different times of day) within one week.
- For more information on the science content in this lesson, refer to the “Sun’s Daily Pattern” section of the Teacher Background Information, on page 417.

Lesson 3

Standards and Benchmarks

This lesson demonstrates Earth and Space Science Standard D (Objects in the Sky): “The sun... [has] properties, locations, and movements that can be observed and described.” The children’s observations reinforce Physical Science Standard B (Position and Motion of Objects): “The position of an object can be described by locating it relative to another object or the background,” and “An object’s motion can be described by tracing and measuring its position over time.”

Lesson Goals

1. Realize that the sun appears to travel in an arc across the sky every day.
2. Consider the requirements for making accurate observations of the change in the sun’s position throughout the day, such as standing in the same place, marking landmarks, and looking at shadows.

Assessment

Use the introductory discussion as a summative assessment of how well children understand criterion C in Assessment 5. The exploration and synthesizing discussion provide appropriate opportunities to assess children’s understanding of criterion B.

You may also choose to offer the children a task that requires them to apply their knowledge. For example, provide a drawing of a tree with its shadow early in the morning. Have children add to the picture to show where the shadow would be in the middle of the day and in the late afternoon.

In addition, assess the children’s development in making predictions since Lesson 2. Apply criteria A and B in Assessment 2 during the exploration and synthesizing discussion.

NOTES

Our Solar System Assessment 5: Daytime Sunlight
As you evaluate the children’s discussions, their work in their science notebooks, and their models, consider whether they demonstrate understanding of the following concepts.

Children’s Names	Assessment Criteria:		
	A. The sun is Earth’s source of light and heat.	B. The sun’s light travels in a straight path to Earth.	C. Shadows are created when an object blocks the straight path of sunlight.
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Assessment 5: Daytime Sunlight Our Solar System Teacher Master 8

Teacher Master 8, Assessment 5

Our Solar System Assessment 2: Predicting
As you evaluate the children’s discussions and their work in their science notebooks, consider whether they demonstrate understanding of the following concepts.

Children’s Names	Assessment Criteria:		
	A. Information gathered, data, and previous knowledge should be used to make predictions.	B. Predictions can be based on patterns identified in data.	C. Incorrect predictions can be added to data base to form more accurate predictions.
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Assessment 2: Predicting Our Solar System Teacher Master 5

Teacher Master 5, Assessment 2

Materials

Item	Quantity	Notes
ExploraGear		
Magnetic compass	1 for teacher	To find north.
Self-sticking notes, small	1 pack	For predicting sun's position on sketch.
Classroom Supplies		
Alarm clock or kitchen timer (optional)	1	To remind children of observation times.
Chalk	1 piece	To mark cardinal directions.
Chart paper	1 pad	To draw sun's position in sky.
Colored markers	1 set	To draw sun in sky and draw landmarks on sketch.
Colored pencils	1 per child	To mark predictions.
Easel	1	To prop chart paper outside. Any large and stable display for drawing may be substituted instead.
Pencils	1 per child	To record outdoor observations.
Street map of area (optional)	1	To find north in relation to school.
Watch	1 for teacher	To note observation times.
Curriculum Items		
<i>Our Solar System Science Notebook, pages 6-7</i>		
<i>Teacher Directions "Finding North Using a Compass or Shadows," pages 96-97</i>		
<i>Our Solar System Assessment 2: Predicting (optional)</i>		
<i>Our Solar System Assessment 5: Daytime Sunlight (optional)</i>		

NOTES

Preparation

- This lesson requires a clear day during which the sun is visible. Because the children need to make a minimum of three observations, you may choose to do the lesson in one day or over several days. If you make observations on multiple days, make sure that they are all within the same week, and that they are at different times of day (e.g., morning, mid-day, afternoon).

- ❑ Plan your day (or days) so that the children can observe the position of the sun three or four times. One of those times should occur close to noon, and all of the times should be more than an hour apart. Possibilities for planning include:
 - Make observations once in the morning (meeting the class outside as it arrives), once at lunch, and once in the afternoon (taking the class outside before dismissal).
 - Structure the day's other subjects around the science sessions, and between subjects take the children outside as a group.
 - Make the first observation with the whole class, and then allow children to go outside in small groups when they have available time.
 - Arrange for adult volunteers to accompany small groups outside.
 - Make the observations through a window, especially if your classroom does not have convenient outdoor access.
- ❑ Find an outside location that you can return to for multiple observations and that has several obvious, distinct landmarks (such as trees or buildings) towards the south that can be used as reference points.
- ❑ Determine which direction is north at the observation area you decide to use. Use a compass or shadow data (see **Teacher Directions "Finding North Using a Compass or Shadows"** on pages 96-97), or use a street map of the area to identify the school's location and find which direction is north. If you use shadow data, you will need to find north at noon the day before the lesson. Mark the cardinal directions on the ground with chalk. You will set up the easel, chart paper, and markers for the exploration facing south.



- ❑ Assemble the items you need to bring outdoors for the activity:
 - Easel or other large and stable display for drawing
 - Chart paper
 - Colored pencils
 - Markers
 - Materials to locate north (if you haven't done so already)
 - Self-sticking notes
 - Watch
 - Science notebooks

Vocabulary

landmark A permanent feature in a landscape. It can help you figure out where you are, and you can compare its location to the location of moving objects.

Teaching the Lesson

Engage

Introductory Discussion

1. Review what the children did in Lesson 2, and ask questions to determine what they learned about the sun's position in the sky:
 - How did the shadows they observed change throughout the day? (*They moved around the pole, and lengthened or shortened.*)
 - What caused the shadows to change? (*Some children may relate the shadows' changing positions and sizes to the sun.*)
 - How can we see whether the sun's position in the sky changes during the day? (*Responses might include making multiple observations of it throughout the day, or watching shadows over time.*)
2. Explain that today they will be making several observations of the sun to determine if and how its position in the sky changes throughout the day.

Explore

SAFETY NOTE: Before you go outside, remind the children to never look directly at the sun. Looking at the sun causes permanent eye damage.

Locating the Sun in the Sky

1. Bring the children outside to the observation location you selected and sit them facing south. Set up the easel with chart paper and permanent markers in front of the children. Have a watch handy for telling children the time.

TEACHER NOTE: In the continental United States, the sun is in the southern sky most of the time. During the summer, up until the autumnal equinox on September 22, the sun rises north of east. From the autumnal equinox until the spring equinox on March 21, the sun rises south of east.

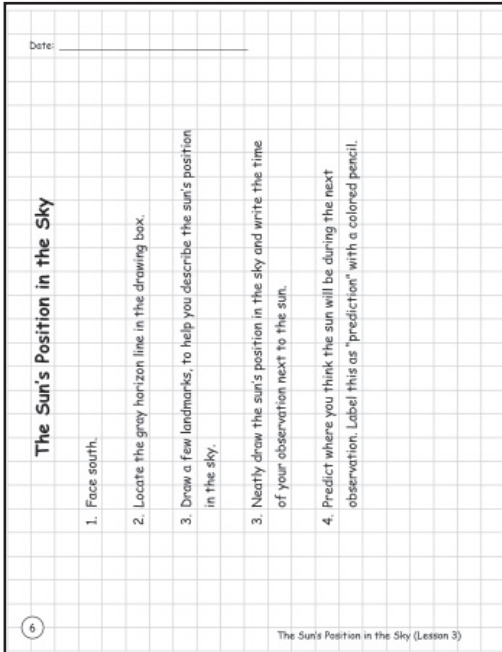
2. Enlist the children in thinking of strategies for finding the sun's location in the sky since no one can look directly at it.
 - a. Suggest that each child turn to a child next to them for a brainstorming session.
 - b. Have children share their strategies with the rest of the class. (*Responses might include finding objects on the ground below the sun in the sky, finding clouds near the sun, or measuring the sun's distance above the horizon.*)
4. Suggest the importance of using landmarks to note the relative position of things, and discuss what makes a good landmark.
 - a. Ask what specific landmarks could help mark the sun's position in the sky.
 - b. Sketch the children's ideas on the chart paper as they list them.
 - c. Once the children agree that they have located enough landmarks, have a child come up and draw where the sun is in the sky on the diagram you started.



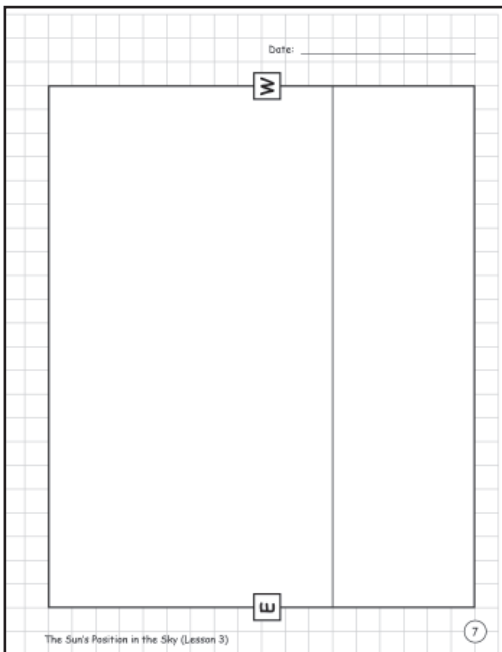
NOTES

 **assessment opportunity**

Assess how the children's skill at making predictions has developed since Lesson 2.



Science Notebook page 6



Science Notebook page 7

TEACHER NOTE: If this observation is done in the morning, the sun should be to the child's left, casting a shadow to their right and slightly behind them.

- d. Label the sun drawing with the time.
 - e. Determine which landmarks were most relevant to finding the sun's position, and confirm that they are permanent features.
5. On page 7 in their science notebooks, have the children draw the selected landmarks and the sun's position and note the time of the observation.
 6. Have everyone make a prediction about the sun's next position:
 - When they come back outside later (around noon), where do they think the sun will be?
 - What can they do if they want to see whether the sun's position has changed? (*Draw where the sun is next time on the same sketch, and compare its place to where they drew the sun the first time.*)
 7. Direct the children to mark and label their prediction of the sun's location on their drawing. Ask several volunteers to share their predictions with the class. Give volunteers a self-sticking note, and have them post their predictions on the chart paper.
 8. Describe how they will make their remaining observations throughout the day. (See suggestions in the Preparation section, above).
 - A different volunteer will record the position and time of their observation on the chart paper.
 - Everyone will record the sun's position in their science notebooks, and make a prediction about the next sighting using a different colored pencil.

TEACHER NOTE: Three observations are the minimum for this activity. Ideally, enough observations need to be made so that the children get a sense of the sun's relative movement across the sky during the daytime. If you make observations on multiple days, make sure they are all within the same week and are at different times of day (e.g., morning, mid-day, afternoon).

MANAGEMENT NOTE: The children could set an alarm clock or a kitchen timer as a reminder to make their next observation.

Reflect and Discuss

Synthesizing

Once the final afternoon observation has been made, have children discuss their findings. Probe their understanding with questions such as:

- Why was it important to use the same landmark(s) for each observation? *(To make accurate observations, the location needed to remain the same.)*
- How did their predictions relate to their actual observations? Were they surprised at the results? *(Many of the children's initial predictions may have been incorrect. However, as the day progressed and their data increased, they should have found their new predictions more consistent with their actual observations.)*
- Did the sun's relative position change throughout the day? How? *(Yes, as the day progressed, the sun appeared to move from east to west across the sky.)*
- What is the shape of the sun's apparent path in the sky? *(Responses might include rainbow, frown, bridge, a half circle, arc, etc.)*
- If they did the same activity next week, do they think they would get the same results? Why? *(Yes, the sun rises, moves across the sky, and sets in an arc each day and week—although the times of sunrise and sunset change throughout the year.)*
- Based on their observations, where do they think the sun goes in the evening? *(Many children will say the sun goes to the other side of the world.)*
- How does the sun's change in relative position relate to the science talk in Lesson 1 about what makes daytime and nighttime? *(The way the sun appears to move across the sky during the day makes daytime. When the sun is not visible in the sky, it's nighttime.)*

TEACHER NOTE: At this point in the unit, do not be surprised if children have the misconception that the sun goes around Earth once each day, making daytime and nighttime. By now the children should understand that the sun appears to travel through the sky in a predictable daily pattern; however, they might still attribute this notion to the sun going around Earth, rather than Earth rotating on its axis. The earth's rotation is the focus of Lesson 7.

MANAGEMENT NOTE: For children who already know that Earth travels around the sun, ask them to explain what they know in the context of today's observations and any investigative questions posed during Lesson 1.

NOTES

You may choose to hold this discussion on another day and use it as an assessment opportunity.



Materials: Light sources, spheres, solid geometrical shapes, flat geometrical shapes

Further Questions

If time permits, return to the investigative questions the children generated in Lesson 1.

- As a result of their most recent observations of the sun, are there any questions they want to add?
- Have any of their questions been answered as a result of today's activity?

Ongoing Learning

Science Center

Provide light sources, some spheres (any kind of ball), some solid geometrical shapes (blocks, cylinders, cones, and pyramids) and some flat shapes (paper plates, cardboard squares, and cardboard triangles). Invite the children to use the shapes to cast shadows, asking:

- Which objects can be used to cast a shadow in the shape of a circle?
- An oval?
- A square?
- A rectangle?
- A triangle?
- Any other shapes?

Extending the Lesson

Further Science Exploration

Watching the Moon for a Day

Lesson 9, "Watching the Moon for a Day," is similar to this lesson. On a day when the moon is visible during daytime, the children use landmarks to track the moon as it appears to move across the sky. If you want, you can teach Lesson 9 before you begin the Our Moon's Cycle cluster. In fact, you may have better luck finding a clear day when the moon is visible if you are flexible about when you teach the lesson.

Find out which days the moon will be visible during school hours by checking web sites listed at www.sciencecompanion.com/links, or by referring to the Teacher Directions "Finding the Moon in the Sky" on page 176.

Like the sun, the moon appears to move across the sky daily because of the rotation of Earth. This topic is explored in Lesson 7, "Earth Rotates."

Making a Sundial

On sunny days it is possible to tell time using a sundial. Choose a spot outside that receives full sun all day.

1. Turn a flower pot upside down.
2. Using a stick that is twice the height of the flowerpot, push the stick through the flowerpot's base hole and into the ground.
3. Every hour, mark the position of the shadow cast by the stick. Once done, on other sunny days the children will be able to tell the time from the marks on the sundial.

Measuring the Sun's Position with Fists

Teach how to measure the position of the sun in the sky without using any tools.

1. Hold one arm straight out to the side and slowly move it forward until it is straight out in front of them. Explain that the difference between the position where their arm started out and where it is now is called 90° .

TEACHER NOTE: If children are not familiar with 90° , use and model the term "square corner" instead.

2. Stand still and put one arm out in front at eye level, with their hand in a fist, then close one eye.
3. Carefully begin moving the arm stiffly, watching and counting how many fists can line up side by side until the arm is 90° away from where they started, or straight out to their side.
4. Use things around them as guides to help count the imaginary fists.
5. Show how dividing 90° by the number of fists they counted gives them how many degrees of the sky their fist covers!

TEACHER NOTE: An average fist covers 10° of the sky. The value the children calculate should be close to this.

6. Using this value, estimate the sun's position in the sky by counting how many fists it is above the horizon.



Mathematics Extension

Defining the Parts of a Circle

1. With a can or other cylindrical object, trace around *part* of the bottom of the object on a sheet of paper.
 - What's on the paper when the object is lifted? (*Part of a circle.*)
2. Put the can back down where it was and trace some more—but still not all the way around the can.
 - When the object is lifted now, what's on the paper? (*A longer part of a circle.*)
3. Write the word “arc” on the board, and explain that it is a name for a part (segment) of a circle or curve. An arc is anything shaped like a bow, curve, or arch.
 - Where have they seen examples of arcs?
 - Do they remember seeing an arc from tracing the path of the sun across the sky?
4. Put the can back down on the paper and trace all the way around it.
 - When the object is lifted now, what's on the paper? (*A circle.*)
5. Write the words *circle* and *circumference* on the board. Explain that “circumference” is a name for the distance around the whole outside of a circle. (If the children know what a perimeter is, explain that circumference is a special word for the perimeter of a circle.)
6. Cut out the circle and fold it in half.
7. Write the word *diameter* on the board. Explain that the fold is the diameter of the circle, and that it is the distance across the circle through its center.
8. Fold the circle in half again, and then open the circle up.
 - Explain that the point where the two folds meet is the center of the circle.
9. Measure across the diameters of the paper circle and the object.
 - Is the diameter the same in both directions along the folds on the paper circle?
 - Is the diameter the same across the center of the object?
 - What is the outside half of the circle called, between the two places where the ruler measures diameter? (*An arc.*)

Art Extension

Drawing Arcs

Draw the shape of the sun's apparent movement (an arc) on a sheet of paper. What else could be made from that shape? With a variety of art supplies, extend the arc shape into a new creation. Think of titles for the pieces that include the word "arc."

Social Studies Extension

Reading a Compass Rose

On a blank copy of a compass rose, fill in the directions (north, south, east, west). Look at a map of the United States. Ask questions that will elicit understanding that a map shows how a place looks from above, and answers that involve identifying directions, such as:

- What is a bird's-eye view?
- Where are we on the map?
- How should the compass rose be placed on the map so it lines up with the right compass directions?
- What direction is San Francisco?
- What direction is New York?
- What direction is Texas?
- What direction is Canada?

Planning Ahead

For Lesson 4

During the next lesson the children will spend part of day outdoors using scientific tools to record the position of the sun. The following steps need to be completed before beginning the lesson:

- Assemble the shadow-recording tools at least one day before teaching the lesson. The air-drying clay used to make the base of the shadow-recording tools needs 24 hours to harden. (See the Teacher Directions "Making the Shadow-Recording Tools" on page 114.)
- Identify a shadow viewing area to paint (or outline with chalk or masking tape) rectangles. See the Preparation section in Lesson 4 for more information.



Teacher Directions

Finding North Using a Compass

Materials

Item	Quantity	Notes
ExploraGear		
Magnetic compass	1 per class	To find north.
Classroom Supplies		
Chalk	1 piece	To mark cardinal directions.

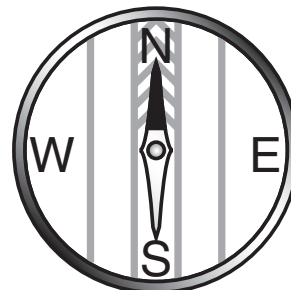
NOTES

Directions

1. Find an outside location with a flat, hard surface where the children can estimate the sun's position at least three times throughout the day. The location should have several obvious, distinct landmarks (such as trees or buildings) that can be used as reference points while making observations and should be in a place that will not be disturbed during the day.
2. Holding the compass as flat as possible, line up the compass arrow with the N on the compass (see figure below). Set it on the flat, hard surface.
3. In the direction the compass arrow is pointing, write N for north in chalk.
4. At the bottom point of the arrow, write S for south in chalk.
5. On the left, write W for west in chalk.
6. On the right, write E for east in chalk.

TEACHER NOTE: The north arrow actually points to Earth's magnetic North Pole, which is close to but different from Earth's geographic North Pole. For these lessons, they are treated as if they were the same.

7. Set up the easel, chart paper, and markers facing south for the exploration.



Finding North Using Shadows

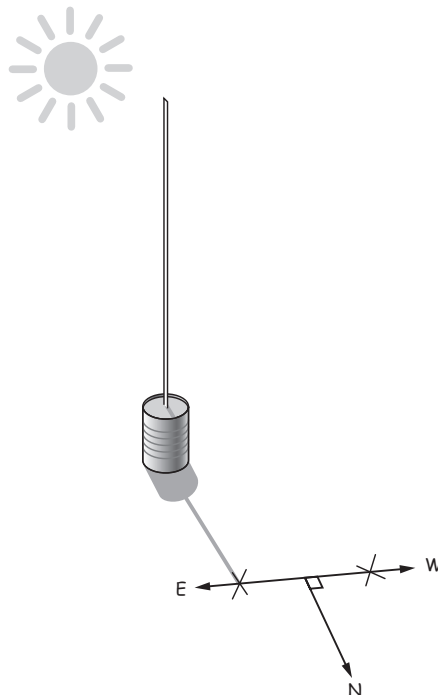
Materials

Item	Quantity	Notes
Classroom Supplies		
Chalk	1 piece	To mark cardinal directions.
Coffee can	1 per class	To hold a stick for finding north.
Meter stick	1 per class	To make a shadow for finding north.
Sand	4 cups	To hold a stick for finding north.

Directions

1. Find an outside location with a flat, hard surface where the children can estimate the sun's position at least three times throughout the day. The location should have several obvious, distinct landmarks (such as trees or buildings) that can be used as reference points while making observations and should be in a place that will not be disturbed during the day.
2. Assemble the shadow-recording tool by filling a coffee can halfway with sand. Place the meter stick pointing out of it.
3. Set the shadow-recording tool on the ground; make sure the stick is pointing upright.
4. Around midday, mark the end point of the shadow using chalk.
5. Wait one hour and mark the end point of the new shadow point using chalk.

6. Draw a line to connect the two points. The line from the first mark to the second mark will be approximately west→east (see figure at right).
7. Draw a perpendicular line through the west→east line. Mark this line south-north.
8. Set up the easel, chart paper, and markers facing south for the exploration.



Date: _____

The Sun's Position in the Sky

1. Face south.
2. Locate the gray horizon line in the drawing box.
3. Draw a few landmarks, to help you describe the sun's position in the sky.
3. Neatly draw the sun's position in the sky and write the time of your observation next to the sun.
4. Predict where you think the sun will be during the next observation. Label this as "prediction" with a colored pencil.

6

The Sun's Position in the Sky (Lesson 3)

Date: _____

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7

The Sun's Position in the Sky (Lesson 3)

Teacher Master 5, Assessment 2

Our Solar System Assessment 2: Predicting

As you evaluate the children's discussions and their work in their science notebooks, consider whether they demonstrate understanding of the following concepts.

Children's Names	Assessment Criteria:		
	A. Information gathered, data, and previous knowledge should be used to make predictions.	B. Predictions can be based on patterns identified in data.	C. Incorrect predictions can be added to data base to form more accurate predictions.
1.			
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Assessment 2: Predicting Our Solar System Teacher Master 5

Teacher Master 8, Assessment 5

Our Solar System Assessment 5: Daytime Sunlight

As you evaluate the children's discussions, their work in their science notebooks, and their models, consider whether they demonstrate understanding of the following concepts.

Children's Names	Assessment Criteria:		
	A. The sun is Earth's source of light and heat.	B. The sun's light travels in a straight path to Earth.	C. Shadows are created when an object blocks the straight path of sunlight.
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Assessment 5: Daytime Sunlight Our Solar System Teacher Master 8