Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 5 Science

Unit 4 Instructional Framework

Earth and Its Gravitational Force and Motion

August 2023

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Unit 4 Overview

Storyline Synopsis:

This unit consists of four segments, each engaging students in multiple science and engineering practices as students make sense of the key disciplinary ideas about the direction of the Earth's gravitational forces and how distance from the Earth influences the brightness of the sun and stars.

- **Instructional Segment 1:** By engaging in the practices of developing and using models, constructing explanations and designing solutions, analyzing and interpreting data, and engaging in argument from evidence, students learn about size, brightness, and distance of stars in the sky about the sun. Students begin the unit by exploring an anchoring phenomenon based on their observations of what is in the sky as seen in media, stories they have heard, or their actual surroundings. Possible driving questions include, "Why doesn't the moon fall to the Earth?", "Why is everyone's sky different?", etc. This investigation is revisited in the segment as students learn more about stories about constellations from an indigenous community.
- **Instructional Segment 2:** By engaging in the practices of developing and using models, analyzing and interpreting data, and engaging in argument from evidence, students learn about the pull and direction of the Earth's gravitational force and how weights of different objects are related. Students explore why many planetary objects are spherical in shape and compare the direction of the Earth's gravitational force on various locations on the Earth.
- **Instructional Segment 3:** By engaging in the practices of developing and using models, analyzing and interpreting data, and engaging in argument from evidence, students develop their familiarity into a deeper understanding of the movement and patterns of the Earth's rotation and revolution, causes of day/night, and effects on shadows. Then, students engineer designs of an ancient instrument from which to construct deeper explanations beyond their daily familiarity with day/night and shadows.
- **Instructional Segment 4:** By engaging in the practices of engaging in argument from evidence, planning and carrying out investigations, and analyzing and interpreting data, students learn how the position of the sun and the orbit of the moon around the Earth explains its four phases. They also learn about how the Earth's tilt and rotation around the sun affect daily and seasonal patterns. Students are able to revisit the anchoring phenomenon of the observation of the sky and use the data they have gathered as evidence of why they see different stars at different times of the year.

Unit Storyline Framing:

The teacher opens the unit by asking students what they know about constellations and creating a list of constellations (e.g., big/little dipper). The class reads/listens to a story about Indigenous astronomy and considers how not all cultures have the same constellations. Using the idea of different constellations as inspiration, students develop questions about large astronomical objects in the sky, their movement, and then create their own constellation and a matching story in the sky. Students observe their constellations and movement, creating a focus for their observations and understanding how and why objects appear to move about the sky.

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Stage 1 – Desired Results

Overview of Student Learning Outcomes

The Grade 5 Unit 4 Topic Bundle, "**Earth and its Gravitational Force and Motion**," organizes performance expectations with a focus on development and use of models that explain how Earth's spin is related to how much sunlight is received in any location and how Earth's gravitational force is always directed downwards. Also, through use of mathematical and computational thinking, students can show how the distance of the Earth from the sun and stars influences their brightness. In working with these disciplinary core ideas, students are positioned to understand physical phenomena such as day and night and the brightness of the stars in the sky.

Unit 4 Big Ideas:

PS2.B: Types of Interactions	1. Earth's gravitational force pulls all objects near Earth's surface down towards the planet's center. (5-PS2-1)
ESS1.A: The Universe and its Stars	2. The sun is a star that appears larger and brighter to us (on Earth) than other stars because it is closer to Earth. (5-ESS1-1)
ESS1.B: Earth and the Solar System	3. Orbits of Earth around the sun (and moon around Earth) lead to observable patterns (different appearances of constellations in the night sky, and different locations the sun (and moon) appear in the sky throughout the year). (5-ESS1-2) 4. Rotation of Earth about its axis (24-hour cycle) leads to observable patterns (day/night, shadow lengths, change in position of sun (and moon) throughout the day). (5-ESS1-2)

The SIPS Unit 4 Student Profile describes what students should know and be able to demonstrate prior to and at the culmination of three-dimensional science instruction in Unit 4 to prepare for new and increasingly sophisticated learning opportunities in Unit 4.

Next Generation Science Standards (NGSS) Performance Expectations & Foundation Boxes

5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down. [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [*Assessment Boundary: Assessment does not include mathematical representation of gravitational force.*]

5-ESS1-1. Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth. [*Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).*]

5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.] [*Assessment Boundary: Assessment does not include causes of seasons.*]

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Targeted Scientific Practices	Targeted Disciplinary Core Ideas	Targeted Cross-Cutting Concepts
[SEP-4] Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. **(5-ESS1-2)** **[SEP-7] Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model. **(5-PS2-1) (5-ESS1-1)**	**PS2.B: Types of Interactions** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. **(5-PS2-1)** **ESS1.A: The Universe and its Stars** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. **(5-ESS1-1)** **ESS1.B: Earth and the Solar System** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. **(5-ESS1-2)**	**[CCC-1] Patterns** • Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena. **(5-ESS1-2)** **[CCC-2] Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change. **(5-PS2-1)** **[CCC-3] Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large. **(5-ESS1-1)**

Acquisition Goals

Students will know and be able to . . .

A1. Develop and/or use a model to describe that light from stars reaches Earth even when those stars' distances vary greatly.

A2. Support an argument that stars range greatly in their distance from Earth and they emit light that can reach Earth, using evidence, data, or a model.

A3. Represent data in graphical displays to reveal that the sun is closer than other stars and that the sun appears larger and brighter than other stars.

A4. Construct an explanation of the observed relationship between distance and apparent size/brightness of the sun versus all other stars.

A5. Develop and/or use a model to describe that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.

A6. Use evidence (models, observations, or data patterns) to construct or support an explanation that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.

A7. Represent data in graphical displays to reveal patterns of change in the amount of sunlight over 24 hours as the Earth rotates.

A8. Use evidence to support an argument that Earth's rotation about its axis causes differences in the amount of sunlight that reaches a given location on Earth over the course of 24 hours (e.g., darkness at night, dim light at sunrise that increases to daylight, decreasing light at sunset).

A9. Represent data in graphical displays to reveal differences in length and direction of shadow over a 24-hour period.

A10. Organize simple data sets to reveal patterns of change in length and direction of a shadow over a 24-hour period.

A11. Use a model to describe that Earth's gravitational force pulls objects down to the Earth's surface.

A12. Analyze and Interpret data to demonstrate that Earth's gravitational force pulls objects down to the Earth's surface.

A13. Use evidence (models, observations, or data patterns) to construct or support an explanation that the Earth's shape is spherical.

A14. Analyze and interpret qualitative data to show that gravitational force acting on two objects is always a pull.

A15. Use a model to describe that gravitational force can act at a distance even if objects are not in contact with each other.

A16. Analyze and interpret data on the length of the days at a location to determine how the length of the day changes throughout the year.

A17. Analyze and interpret data on the visible constellations at a location to determine if some constellations are visible throughout the year.

A18. Engage in argument from evidence on why some constellations are visible at a location only at some part of the year.

A19. Support an argument that the gravitational force exerted by Earth on objects is directed down.

A20. Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.

Cross-curricular Integration

Students deepen their knowledge of the direction of Earth's gravitational forces and how distance from the Earth influences the brightness of the sun and stars. They also learn about how the rotation of the Earth and moon influences the daily patterns of physical phenomena. In this unit, there is significant overlap and synergy between the DCI and CCC dimensions, where patterns reveal that Earth's gravitational force is always directed downwards while systems and system models and cause and effect show how Earth's rotation causes differences in the amount of sun that reaches a particular physical location. Similarly, the SEPs allow students to construct explanations, use mathematical and computational thinking, and consider other evidence to develop models and explanations around Earth's spin on its axis, its distance from the sun and other stars, and understand what causes day and night.

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Common Core State Standards for Literacy	Common Core State Standards for Mathematics
Reading Informational **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. **(5-PS2-1) (5-ESS1-1)** **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. **(5-ESS1-1)** **RI.5.8** Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). **(5-ESS1-1)** **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. **(5-PS2-1) (5-ESS1-1)** ***Writing*** **W.5.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. **(5-PS2-1) (5-ESS1-1)** ***Speaking and Listening*** **SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. **(5-ESS1-2)**	***Mathematical Practice*** **MP.2** Reason abstractly and quantitatively. **(5-ESS1-1) (5-ESS1-2)** **MP.4** Model with mathematics. **(5-ESS1-1) (5-ESS1-2)** ***Geometry*** **5.G.A.2** Represent real-world and mathematical problems by graphing points in the first quadrant of the coordinate plane and interpreting coordinate values of points in the context of the situation. **(5-ESS1-2)** ***Numbers and Operations in Base Ten*** **5.NBT.A.2** Explain patterns in the number of zeros of the product when multiplying a number by powers of 10 and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. **(5-ESS1-1)**
Enduring Understandings	***Essential Questions***
Students will understand that . . . **EU1.** Forces act on objects and influence how they move (e.g., gravity causes objects to move towards the Earth's center). **EU2.** Patterns can be used to analyze and communicate changes in natural phenomena that occur due to the position and motion of the sun, moon, Earth, and stars. **EU3.** Data can be displayed in a variety of ways to reveal patterns that indicate relationships, including in graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships. **EU4.** Scientific arguments are based on evidence and reasoning. Consumers of science can evaluate	**EQ1.** What causes objects to move? **EQ2.** How can observable patterns of the sun, the moon, and the stars in the sky be used to understand and explain natural phenomena? **EQ3.** In what ways can data be represented? **EQ4.** How do I use evidence and data to support my argument?

whether scientific claims are supported by evidence and data.	

Vocabulary

• Gravity	• Constellation	• Rotation
• Gravitational force	• Orbit	• Revolve
• Solar system	• Star	• Axis
• Universe	• Astronomer	• Tilt
• Phases	• Weight	• Light year
• Absolute brightness	• Apparent brightness	• Diameter

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Stage 2 – Assessment Evidence
Assessment Overview
For each of the acquisition goals listed in the Stage 1 – Desired Results, evidence statements were developed. These statements provide information on what we would expect students to do in order to determine the degree to which students have met the acquisition goals. These acquisition goals and evidence statements were then sequenced into instructional segments. Evidence statements were then sequenced into instructional segments. Evidence statements and acquisition goals that were deemed critical were identified and assessment opportunities were developed. For this unit, four segments were identified. An overview of each segment is provided below. **Instructional Segment 1** focuses on Big Idea 2 which has students develop models; construct explanations; analyze and interpret data; and engage in argument from evidence to understand more about patterns that they observe in the sky. Students are informally assessed on their understanding of patterns in what they observe and learn about objects in the sky. Students are formally assessed on their ability to generate graphical representations and models and use those to support arguments related to the idea that the apparent brightness of the sun and stars is due to their relative distances from the Earth and that even though stars may be a great distance they can emit light. **Instructional Segment 2** focuses on Big Idea 1 which has students develop and use models, analyze and interpret data, and engage in argument from evidence to understand more about the direction of Earth's gravitational pull in different locations and on different objects. Students are formally assessed on how gravitational force acts on different objects and how it pulls objects down to the Earth's surface. Students are formally and informally assessed on their ability to use models and analyze and interpret data to support claims related to Earth's gravitational pull and why it is round. This includes using Earth's gravitational force towards its center to support the argument that it is round in shape. **Instructional Segment 3** focuses on Big Idea 4 which has students develop and use models, analyze and interpret data, construct explanations, and engage in arguments from evidence to explain what causes shadows to change throughout the day and how it is related to the movement of the Earth around the sun. Students are informally assessed about sunrise and sunset, daily activities, what causes those changes, and how they're connected to movements of the Earth. Students are formally assessed on their ability to represent data, identify patterns in the data, and use the data to support conclusions related to the movement of the Earth on its axis, the amount of sunlight during the day, patterns of sunlight across the year, and the length and directions of shadows. **Instructional Segment 4** focuses on Big Idea 3 which has students engage in argument from evidence and analyze and interpret data to understand patterns in the sky throughout the year. Students are informally assessed on what causes sunrise and sunset and the role of Earth's rotation in daily observations of the sky. Students are formally assessed on their ability to analyze and interpret data and engage in arguments about how the length of day changes in a chosen location as well as the visibility of constellations throughout the year. **End-of-Unit Stackable, Instructionally embedded, Portable Science (SIPS) Assessment:** For the end-of-unit SIPS assessment, students engage in three scenario-based assessment tasks. The tasks focus on the PEs: 5-PS2-1, 5-ESS1-1, 5-ESS1-2.

Instructionally embedded Assessments

For each instructional segment, descriptions of *informal* and *formal* instructionally embedded assessments are included based on the acquisition goals and evidence statements deemed critical to assess along an instructional plan. Informal assessments defined as "in the moment" assessment opportunities identify student challenges and lack of knowledge or misconceptions and could include class check-ins such as discussion prompts, exit tickets, or graphic organizers. Formal assessments measure how well students perform when engaging with more complex tasks that require integration of the dimensions (SEPs, DCIs, CCCs) in the service of sense-making. They are administered at specific, intentional points in time along an instructional plan before or after a lesson or a series of lessons. Examples include performance tasks, concept maps, research projects, or hands-on tasks.

Instructionally embedded Assessments for Use during Instructional Segment 1

Informal Assessment: Schoolyear Sky Journal

NOTE: This informal assessment should begin at the start of the school year if possible. As a class, students develop a sky journal where they record the time the sun rose and sun set and make observations of the sun and stars at a set time in the evening/night. The teacher divides up the time for observations so that all students have an equal amount of time. The teacher determines the time of evening/night observations based on their local conditions, making sure that it is late enough that students are able to observe the night sky, but not too late for the students. If students are unable to make observations at night or start later in the school year, students could use a simulated sky such as Stellarium to make observations at a set time in the past. The teacher may also want to use Stellarium if they find that the time they set for observations is too early at points in the year. Students document their observations in a shared journal or table.

Assessment Purpose and Use

- To assess students' ability to gather and interpret data on the appearance and motion of the sun, moon, and stars.
- This assessment can be used throughout the unit.

Administration Time: 15 minutes to explain, 5-10 min per day for student observation.

Scoring Time: 10 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Hands-on Task

Discussion prompts

These assessments will assess students' ability to:

- Develop and or use a model to describe that light from stars reaches Earth even when those stars' distances vary greatly.
- Identify evidence to support an argument that stars range greatly in their distance from Earth and they emit light that can reach Earth using evidence, data, or a model.
- Identify evidence to support an explanation of the observed relationship between distance and apparent size/brightness of the sun versus all other stars.
- Describe how to use/develop a model that shows that the Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Describe patterns in data related to how the length of the day changes throughout the year.

- Represent data about the length of the day at a location to show how the length of the day changes through the year.
- Use data to support conclusions about how the length of the day changes throughout the year.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):
- Stories in the Sky
- The Sun and Stars
- Big, Small, it is all Relative
- Where do the Stars go During the Day?

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-1	MP.2	EU2/EQ2	A1
	MP.4	EU4/EQ4	A2
	5.G.A.2		A4
	5.NBT.A2		A5
			A16

Formal Assessment: Twinkle, Twinkle Little Star

Students are given a sheet of photos of 10 stars, including the sun, and how they appear from Earth. They also are given a chart with the distance from Earth, apparent brightness, and stellar radius (along with definitions). They are given the following task: Order the photos based on the distance they are from the Earth. Graph the distances and the brightness of the stars. Use the model and the graph to support an argument that the Sun appears larger and brighter than the other stars. Describe the relationship between distance and the apparent brightness and compare the Sun to the other stars. Use evidence, data, and/or models to support your claim.

Assessment Purpose and Use
- To determine how much support students may need in supporting an argument using evidence in future instruction. The task should be used towards the beginning of the unit to support instruction.

Administration Time: 45 minutes
Scoring Time: 10 minutes
Assessment Type(s)
Formal - Short Performance Task
Assessment Sub-Type(s)
Graphic Organizers
Scenario/Phenomena-based Assessment Task

These assessments will assess students' ability to:
- Describe how data shows that the sun is closer than other stars and/or that the sun appears larger and brighter than other stars.
- Identify evidence that supports an explanation about the relationship between distance and apparent size and/or brightness of the sun versus all other stars.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):
- The Sun and Stars
- Big, Small, it is all Relative

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-1	MP.2	EU2/EQ2	A3
	MP.4	EU4/EQ4	A4
	5.G.A.2		

Formal Assessment: Star Light, Star Bright

Students support an understanding that stars vary in their size and distance from Earth. Students engage in science and engineering practices and use patterns to make sense of the scientific idea that light from stars reaches Earth even if the distances vary. The teacher shares two to four pictures of stars with students as seen from Earth. The teacher gives students the distance of each star from Earth. Students describe the brightness of each star. Students use the pictures and data to support an argument that stars range in their distance, but they still emit light that can reach Earth. Students support an argument that the apparent brightness of the sun and stars is due to the relative distances from the Earth.

Assessment Purpose and Use

- The purpose is to determine how much support students may need in supporting an argument using evidence in future instruction.
- The assessment should be used to support further instruction and to link to the idea of shadows.

Administration Time: 45 minutes

Scoring Time: 20 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Sample Instructionally-embedded Assessment Task: "Star Light, Star Bright"

These assessments will assess students' ability to:

- Identify evidence that supports an explanation about the relationship between distance and apparent size and/or brightness of the sun versus all other stars.
- Identify what evidence or data supports an argument that stars range greatly in their distance from Earth and/or that stars emit light that can reach Earth.
- Describe how data shows that the sun is closer than other stars and/or that the sun appears larger and brighter than other stars.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- The Sun and Stars
- Big, Small, it is all Relative

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-1	MP.4	EU4/EQ4	A1
	SL.5.5		A2
			A3

Formal Assessment: Where do the Stars go During the Day?

Students are given a simple model that functions similarly to the sun and stars, such as a strand of lights being out shown by classroom overhead lights. Students make connections between the string of lights and the stars and to the overhead lights and the sun. Students identify the key features of the model and how they act like the real-world scenario, then propose a new model that incorporates the simple model but better explains the apparent brightness of the sun and stars, including distance, actual brightness, size, and other factors they identified. Students utilize evidence collected while conducting research and hands-on activities to support their logic and reasoning.

Assessment Purpose and Use

- Identify students' understanding of the impact of distance, size, and actual brightness of a star on its apparent brightness here on Earth.
- Provide a summative assessment opportunity for students to demonstrate understanding of the segment.

Administration Time: 45 minutes

Scoring Time: 20 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

These assessments will assess students' ability to:

- Identify what evidence or data supports an argument that stars range greatly in their distance from Earth and/or that stars emit light that can reach Earth.
- Support an argument that stars range greatly in their distance from Earth and they emit light that can reach Earth using evidence, data, or a model.
- Construct an explanation of the observed relationship between distance and apparent size/brightness of the sun versus all other stars.
- Describe how data shows that the sun is closer than other stars and/or that the sun appears larger and brighter than other stars.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- The Sun and Stars
- Big, Small, it is all Relative
- Where do the Stars go During the Day?

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-1	RI.5.8	EU2/EQ2	A1
	RI.5.9	EU4/EQ4	A2
	W.5.1		A3

Informal Assessment: The Sun and Stars

Students explore the core curricular resources and either the internet or teacher-curated resources to gather information about the sun and stars. Students organize the information they find using graphic organizers and other note-taking structures focused on a series of sub-questions that include, but are not limited to:

- What is a star made of?
- Why are some stars brighter than others?
- Which star is closest? Is it the brightest?
- How far away are the stars?
- How can we see the stars?
- What kinds of telescopes do we use to see the stars?
- Why are telescopes bigger or smaller?
- What is the sun?
- How is the sun different from other stars? How is it alike?
- How far away is the sun? How does that compare to other stars?

Assessment Purpose and Use

- To support students' learning as they gather evidence about stars and the sun.
- Provide opportunities for teacher check-in on student understanding of the sun and stars.

Administration Time: 100 minutes

Scoring Time: 5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Research Report

Graphic Organizers

Concept Map

These assessments will assess students' ability to:

- Develop and or use a model to describe that light from stars reaches Earth even when those stars' distances vary greatly.
- Identify evidence to support an argument that stars range greatly in their distance from Earth and they emit light that can reach Earth using evidence, data, or a model.
- Identify evidence to support an explanation of the observed relationship between distance and apparent size/brightness of the sun versus all other stars.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• The Sun and Stars	5-ESS1-1	RI.5.1	EU2/EQ2	A1
		RI.5.7	EU4/EQ4	A2
		RI.5.9		A4

Informal Assessment: My Sky, My Story

After learning about the constellations of different communities, students go out and make their own observations of the night sky. On the first night, students observe stars and try to find constellations as discussed in the anchoring phenomenon and draw their own constellations using the celestial objects they observe (often the brightest objects in the sky are planets). Using the constellations they drew, students write a story that shares an important value with them about their constellations like the legends, lore, and stories of other cultures. (If students are unable to observe the night sky, the teacher provides students with images taken from the local night sky or screen captures from a sky simulator without labels.)

Students come back for the next class and use a simulated sky such as Stellarium to look at the sky as they saw it last night in order to find the stars in their constellation. Students select one star from their constellation and click on it, then click on the "lock" button (a circle with a star in it that appears beneath the information about the star). Students use the date/time feature to advance time, holding the button down. This creates an animation of the night sky focused on their star. They should do this for hours, days, months, and years. As they watch the sky change and their stars move about the sky, students record what they notice. After watching the star animation, students write down what questions they have about their observations and the movement of stars in the sky. (In future segments students gather more detailed data to find patterns, but here the focus is on building interest and generating questions.)

Assessment Purpose and Use

- To build interest in studying the sky and generate questions about the apparent movement of celestial objects.
- To increase awareness of the diverse perspectives in science with a focus on astronomy.

Administration Time: 25 minutes in class

Scoring Time: 5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Hands-on Task

Discussion prompts

These assessments will assess students' ability to:

- Develop and/or use a model to describe that Earth rotates about an axis between its north and south poles and takes approximately 24 hours for a complete rotation. *

- Analyze and interpret data on the visible constellations at a location to determine if some constellations are visible throughout the year. *
- Engage in argument from evidence on why some constellations are visible at a location only at some part of the year. *
- Represent data about the visibility of constellations to determine if some constellations are visible throughout the year. *
- Plan and carry out investigations to find a pattern in what stars are visible at different times of the year. *

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Stories in the Sky	5-ESS1-1	MP.4	EU2/EQ2	A5*
			EU3/EQ3	A19*
				A20*

Instructionally-embedded Assessments for Use during Instructional Segment 2

Informal Assessment: Why Don't We Fly Up Off the Earth's Surface into the Sky? What's Holding Us Down?

The teacher implements frequent informal assessments to reveal students' current understanding of the concepts and practices. Brief assessments such as responses to demonstration prompts, in the moment questions, and graphic organizers about gravity and Earth's gravitational force may be used. Students are asked to engage with data analysis, modeling, and supporting explanations to address concepts around how gravitational force acts on different objects and how it pulls objects down to the Earth's surface.

Assessment Purpose and Use

- To gauge where students are in their understanding and explanations of Earth's gravitational force.
- Provide information to guide what instructional activities will best support students' learning

Administration Time: 5-10 minutes

Scoring Time: 2-5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Discussion prompts

In-the-moment Questions

Exit Tickets

These assessments will assess students' ability to:

- Develop and use a model to show that gravitational force can act at a distance even if objects are not in contact with each other.
- Represent and use data to show that the Earth's gravitational force pulls objects down to the Earth's surface.
- Identify what evidence or data supports an argument that the Earth's shape is spherical.
- Identify what evidence or data supports an argument that the gravitational force exerted by Earth on objects is directed down.
- Use evidence and/or data to support an argument that the gravitational force exerted by Earth on objects is directed down.

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Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):
- Why Are Stars and Planets, like Earth, Round?
- Which Way is Down?
- Round and Down, but How?
- Gravity Brings Us All Together

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-PS2-1	RI.5.8	EU1/EQ1	A11
	W.5.1	EU3/EQ3	A12
	SL.5.5	EU4/EQ4	A13
			A14
			A15
			A19

Informal Assessment: The Earth is Round

Students explore core curricular materials, videos, simulations, and other teacher-curated resources to identify evidence to support the idea of a spherical Earth. Students record their findings in graphic organizers, concept maps, and scientific notebooks. As students explore content, the teacher poses questions that encourage students to think deeply about the topic and justify the evidence they have recorded.

Assessment Purpose and Use
- To determine how much support students may need in representing, analyzing, and drawing conclusions from research.
- To support instruction in future units.

Administration Time: 50 minutes
Scoring Time: 5 minutes
Assessment Type(s)
Informal-Classroom Check-in
Assessment Sub-Type(s)
In the moment questions
Graphic organizers
Concept Maps
Research Report

These assessments will assess students' ability to:
- Identify scientific evidence, data, or models for evidence that the Earth's shape is spherical.
- Identify what evidence or data supports an argument that the gravitational force exerted by Earth on objects is directed down.
- Use evidence and/or data to support an argument that the gravitational force exerted by Earth on objects is directed down.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):
- Round and Down, but How?

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-PS2-1	SL.5.5	EU1/EQ1	A13
		EU3/EQ3	A19
		EU4/EQ4	

Formal Assessment: Which Way is Down?

Students explore content that includes several pieces of evidence to support the claim that the Earth's gravitational forces pull objects down to the Earth's surface. These can include:

- Multiple lines of evidence that indicate that the Earth's shape is spherical (e.g., observation of ships sailing beyond the horizon, the shape of the Earth's shadow on the moon during an eclipse, the changing height of the North Star above the horizon as people travel north and south).
- That objects dropped appear to fall straight down.
- That people live all around the spherical Earth, and they all observe that objects appear to fall straight down.

Students organize the evidence and then evaluate the evidence to determine whether it is sufficient and relevant to supporting the claim. Students describe whether any additional evidence is needed to support the claim. Students develop a multimodal explanatory model to support the claim. Students use reasoning to connect the relevant and appropriate evidence to support the claim with argumentation.

Assessment Purpose and Use

- To determine how much support students may need in representing, analyzing, and drawing conclusions from data.
- To support instruction in future units.

Administration Time: 100 minutes

Scoring Time: 8 minutes

Assessment Type(s)

Formal – Research Project

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Graphic Organizers

These assessments will assess students' ability to:

- Develop and use a model to show that gravitational force can act at a distance even if objects are not in contact with each other.
- Represent and use data to show that the Earth's gravitational force pulls objects down to the Earth's surface.
- Identify scientific evidence, data, or models for evidence that the Earth's shape is spherical.
- Identify what evidence or data supports an argument that the gravitational force exerted by Earth on objects is directed down.
- Use evidence and/or data to support an argument that the gravitational force exerted by Earth on objects is directed down.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Why Are Stars and Planets, Like Earth, Round?
- Which Way is Down?
- Round and Down, but How?
- Gravity Brings Us All Together

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-PS2-1	RI.5.8	EU1/EQ1	A11
	W.5.1	EU3/EQ3	A12
	SL.5.5	EU4/EQ4	A13
			A19

Formal Assessment: Is the Earth Round?

Students are presented with a scenario where someone attempts to argue that the Earth is flat and uses the direction of gravity to support that. Students use their graphic organizers, concept maps, notes, and prior knowledge to support an argument that the Earth is round and that the direction of gravity supports that instead.

Assessment Purpose and Use

- Provide students an opportunity to demonstrate the ability to engage in an argument and support that argument with evidence.

Administration Time: 20 minutes

Scoring Time: 5 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

These assessments will assess students' ability to:

- Develop and use a model to show that Earth's gravitational force pulls objects down to the Earth's surface.
- Identify scientific evidence, data, or models for evidence that the Earth's shape is spherical.
- Identify what evidence or data supports an argument that the gravitational force exerted by Earth on objects is directed down.
- Use evidence and/or data to support an argument that the gravitational force exerted by Earth on objects is directed down.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Gravity Brings Us All Together
- Round and Down, but How?

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-PS2-1	RI.5.1	EU1/EQ1	A11
	RI.5.7	EU4/EQ4	A13
	RI.5.9		A19
	W.5.1		
	SL.5.5		

Instructionally-embedded Assessments for Use during Instructional Segment 3

Informal Assessment: Sun-Earth Model

At the start of Segment 3, students create a sun-Earth model using objects such as polystyrene balls of varying sizes to create a physical model that they can use to explain the observed movements of the moon and sun based on their observations from their *Schoolyear Sky Journal*. Students write an initial explanation that uses their model to explain the movements. The initial model provides an assessment of students' prior knowledge and any misconceptions.

As students progress through Segments 3 and 4, they revisit and refine their models and explanations, providing additional insight into student understanding. Formal assessments of this initial model are listed as part of Segments 3 and 4.

Assessment Purpose and Use

- To determine students' understanding of the sun-Earth system and inform future instruction.
- Used throughout the final two segments.

Administration Time: 10-20 minutes

Scoring Time: 10-15 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Discussion prompts

Graphic Organizers

In-the-moment Questions

These assessments will assess students' ability to:

- Describe how a model shows that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Use a model to show that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Describe patterns in data related to the change in length and direction of a shadow over a 24-hour period.
- Generate mathematical representations of data that show patterns of change in the length and direction of a shadow over a 24-hour period.
- Describe how mathematical representations support conclusions about how the length and direction of a shadow change over a 24-hour period.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Why are Shadows Always Changing?
- Why do we have Time Zones?
- I am Spinning Around
- Time by the Ancient Sundial

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-2	MP.2	EU2/EQ2	A5
	MP.4	EU4/EQ4	A6*
	5.G.A.2		A7*
			A10

Informal Assessment: Movements of the Earth

The teacher implements frequent informal assessments to reveal students' current understanding of the concepts and practices. These brief assessments could include responses to demonstration prompts, in the moment questions, and graphic organizers about the sunrise and sunset, daily activities, what causes those changes, and how they're connected to the movements of the Earth. Students' responses, their explanations of the cause-and-effects of those movement types, use of wording/vocabulary, and connections to their daily lives reveal their current understanding. Reasons for the items used in the demonstrations/activities for modeling and cause-and-effect SEPs and CCCs are frequently assessed informally, as students work through the unit and develop a deeper understanding and explanation of Earth's movements and the effects.

Assessment Purpose and Use

- To gauge where students are in their understanding and explanations of Earth's movements.
- Provide information to guide what instructional activities best support the students' ongoing exploration of the patterns and effects of Earth's movements

Administration Time: 5 minutes

Scoring Time: 5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Discussion prompts

In-the-moment Questions

Graphic Organizers

Concept Map

These assessments will assess students' ability to:

- Develop and use a model to show that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Describe patterns in data related to how the length of the day changes throughout the year.
- Identify evidence that supports an explanation that Earth rotates about an axis between its North and South poles and takes approximately 24 hours for a complete rotation.
- Describe patterns in generated data related to the change in the amount of sunlight over 24 hours as the Earth rotates.
- Use data to support conclusions about patterns of change in the amount of sunlight over 24 hours as the Earth rotates.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Why are Shadows Always Changing?	5-ESS1-2	MP.2	EU2/EQ2	A5
• Why do we have Time Zones?			EU3/EQ3	A6
• I am Spinning Around			EU4/EQ4	A7
• Time by the Ancient Sundial				A8

Formal Assessment: Sunrise and Sunset, how do the Earth and Sun Repeat that?

The Earth's movements have observable patterns that are familiar to students, including the daily occurrences and often beautiful sunrises and sunsets. When watching these, it seems if as the sun is moving around the Earth. In the assessment, students observe a timelapse video of sunrise and/or sunset and complete a template or develop a model that supports their explanation about the Earth's sunlit and dark sides, the sun, and the rotation of the Earth around its axis with relation to the sun. Students are provided with information about the amount of sunlight given in several 24-hour time frames. Students create a representation of this data and use it to support the idea that there are patterns of change in the amount of sunlight over 24 hours. They use this data to support the claim that it takes about 24 hours for the Earth to rotate about its axis.

References:

- New Zealand Sunrise (no copyright) video
  [https://www.youtube.com/watch?v=o_kgdCGisso]
- Nelson, Kara. Measuring Times as Earth Rotates and Revolves. Better Lesson.
  [https://teaching.betterlesson.com/lesson/636195/measuring-time-as-the-earth-rotates-and-revolves?from=cc_lesson]
- Mutch, Jennifer. What Makes Day and Night. Better Lesson.
  [https://teaching.betterlesson.com/lesson/resource/3175695/day-and-night-worksheet.]

Assessment Purpose and Use

- The purpose is to determine how much support students may need in supporting an argument using evidence in future instruction, generating representations of data, and identifying patterns.
- The task should be used towards the beginning of the

Administration Time: 45 minutes

Scoring Time: 5 minutes

Assessment Type

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task unit to support instruction. Graphic Organizers

This assessment will assess students' ability to:

- Describe patterns in generated data related to the change in the amount of sunlight over 24 hours as the Earth rotates.
- Use data to support conclusions about patterns of change in the amount of sunlight over 24 hours as the Earth rotates.
- Describe, use, and/or develop a model to show that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Identify evidence that supports an explanation that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Construct an explanation that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Develop and use a model to show that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Why are Shadows Always Changing?
- Why do we have Time Zones?
- I am Spinning Around
- Time by the Ancient Sundial

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-2	W.5.1	EU2/EQ2	A5
	SL.5.5	EU3/EQ3	A6
	MP.2	EU4/EQ4	A7
			A8

Formal Assessment: Where are you Right Now in the Earth's Rotation?

The Earth's movements have observable patterns. Earth's rotation on its axis causes regular changes such as day and night. Students show their understanding of where they are at that immediate time/moment, in the rotation of the Earth, such as facing toward or away from the sun. Students use evidence of daylight to support their argument about the rotation of the Earth. To show where they are in the rotation, students complete a template or develop a model that includes themselves on the Earth, the Earth's sunlight and dark sides, the sun, and labels explaining the rotation. Students show a contrasting location on the model with another person on the opposite side of the Earth.

Assessment Purpose and Use

- To connect student's everyday life to the rotation of the Earth, the light/dark sides of the Earth, and the Earth's location relative to the sun.

Administration Time: 45 minutes

Scoring Time: 5 minutes

Assessment Type

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Research Report

This assessment will assess students' ability to:

- Describe patterns in generated data related to the change in the amount of sunlight over 24 hours as the Earth rotates.

- Use data to support conclusions about patterns of change in the amount of sunlight over 24 hours as the Earth rotates.
- Identify and use evidence that supports an argument that Earth's spin about its axis causes differences in the amount of sunlight that reaches a given location on Earth over the course of 24 hours.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Why are Shadows Always Changing?
- Why do we have Time Zones?
- I am Spinning Around
- Time by the Ancient Sundial

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-2	W.5.1	EU2/EQ2	A7
	MP.2	EU4/EQ4	A8

Formal Assessment: Shadows Puppets are Changing

This formative assessment (adapted from Keeley Probes) is in the setting of manipulating shadow puppets for a show. The teacher establishes a scenario with a shadow puppet show, and asks, "How would you move the puppet to make the shadow bigger or smaller?", and "Tell us why you think that would work." The teacher continues with the scenario, and asks, "How would the shadow change if the light is moved to the other side of the stage/theater?", and "Tell us why you think that would happen." Responses can be formalized in an exit ticket or graphic organizer. The responses direct the development of instructional explorations about the cause and effect of objects and lights in the production and change of shadows. Students are given data about shadows over a 24-hour period and are asked to organize this data. They are asked to describe patterns in the data related to the length and direction of the shadows over time.

Resources:

- 5-ESS1-2 Assessment - Where Was This Video Shot? - Google Docs [https://docs.google.com/document/d/1AZr9y0fmjUKfPSuabxIeaHKe APQmfLTw7rM_IWtfJzk/template/preview]
- Wonder Sci, Daily Patterns of a Hiking Stick Shadow [https://docs.google.com/document/d/1AEFCANfimNzSV3PhpZXN sn7zL7bdT4cFPGePpxK9OrA/template/preview]
- ShadowSize+w+TNs.pdf (squarespace.com) [https://static1.squarespace.com/static/5f09c80930b545063d089 cc6/t/604a42f58e715d7 a4a58bfe9/1615479542627/ShadowSize+w+TNs.pdf]
- Our Place in the Universe [https://content.schoolinsites.com/api/documents/32b1688a4d3e40b386f33d3cae4680f9.pdf]

Assessment Purpose and Use

- To enable students to show what they currently believe about position and shadow length.
- Serves to inform the teacher's plans for future lesson/instructional activities for students' investigations about shadows.

Administration Time: 45 minutes

Scoring Time: 3-4 minutes

Assessment Type

Formal - Short Performance Task

Assessment Sub-Type(s)

Hands-on Task

Graphic Organizers

In-the-moment Questions

Discussion prompts

Scenario/Phenomena-based Assessment Task

This assessment will assess students' ability to:

- Generate representations of data that show patterns of change in the amount of sunlight over 24 hours as the Earth rotates.
- Use data to support conclusions about patterns of change in the amount of sunlight over 24 hours as the Earth rotates.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Why are Shadows Always Changing?
- Why do we have Time Zones?
- I am Spinning Around
- Time by the Ancient Sundial

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-2	W.5.1	EU2/EQ2	A9
	RI.5.7	EU3/EQ3	A10
	MP.2	EU4/EQ4	
	MP.4		

Formal Assessment: Sun-Earth Model Revisions 1

In this formal assessment, students revise their sun-Earth model and explanation to ensure that they can explain why the sun appears to move across the sky, why shadows change through the day, and how and why the sunlight changes in a 24-hour period. This stage of assessing the model is focused on the Earth's rotation, changes in the sun's position and light, and the changes in shadows as evidence of the Earth's rotation on its axis.

Assessment Purpose and Use

- Check student understanding of the movement of the Earth and how the Earth's rotation is responsible for the apparent motion of the sun in the sky.

Administration Time: 25 minutes

Scoring Time: 8 minutes

Assessment Type(s)

Formal - Extended Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Extended Project

These assessments will assess students' ability to:

- Describe patterns in generated data related to the change in the amount of sunlight over 24 hours as the Earth rotates.
- Use data to support conclusions about patterns of change in the amount of sunlight over 24 hours as the Earth rotates.
- Describe, use, and/or develop a model to show that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Identify evidence that supports an explanation that the Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Construct an explanation that the Earth rotates about an axis and takes approximately 24 hours for a complete rotation.

- Develop and use a model to show that Earth rotates about an axis and takes approximately 24 hours for a complete rotation.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- I'm Spinning Around
- Why do we have Time Zones?
- Time by the Ancient Sundial

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS-2	RI.5.1	EU2/EQ2	A5
	RI.5.76	EU4/EQ4	A6
	RI.5.9		A7
			A8

Instructionally-embedded Assessments for Use during Instructional Segment 4

Informal Assessment: Questioning Our Sun-Earth Model

At the start of Segment 4 students return their sky observations or the simulator to see how the sky changes over a full year. Students consider how their model explains and does not explain this phenomenon. Students generate new questions to research so they can revise their model to be able to explain why constellations move around the sky. As students progress through Segment 4 they should continue to refine this model as they learn more about the movement of the Earth around the sun.

Assessment Purpose and Use

- To gauge where students are in their understanding and explanations about the Earth's revolution around the sun.
- Provide information to guide what instructional activities will best support the students learning.

Administration Time: 30 minutes

Scoring Time: 10 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

In-the-moment Questions

Hands-on Task

These assessments will assess students' ability to:

- Engage in argument from evidence on why some constellations are visible at a location only at some part of the year.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Does Spinning Explain Why My Constellation Moves?
- Daytime, Nighttime, Playtime, Bedtime!
- How Does My Constellation Move?
- My Sun-Earth Model

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-ESS1-2	SL.5.5	EU2/EQ2	A16*
		EU4/EQ4	A17*
			A18*

Formal Assessment: Daytime, Nighttime, Playtime, Bedtime!

Students select a city on Earth and gather data on the sunrise, sunset, daylight, and darkness times. Using digital tools, students gather the data and then create graphs and charts to represent the data. Students share their data representation with the class and use their representations to explain how the length of the day changes at their location.

Science
Grade: 5 Unit: 4
20 days of instruction

Assessment Purpose and Use

- To provide students an opportunity to demonstrate identifying patterns and drawing conclusions from data.
- To check for understanding of the meaning of evidence to support or refute a model.

Administration Time: 75 minutes
Scoring Time: 5 minutes
Assessment Type(s)
Formal - Short Performance Task
Assessment Sub-Type(s)
Scenario/Phenomena-based Assessment Task
Research Report

These assessments will assess students' ability to:

- Describe patterns in data related to how the length of the day changes throughout the year.
- Represent data about the length of the day at a location to show how the length of the day changes through the year.
- Use data to support conclusions about how the length of the day changes throughout the year.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Daytime, Nighttime, Playtime, Bedtime!	5-ESS1-2	W.5.1	EU2/EQ2	A16
		MP.2	EU3/EQ3	
			EU4/EQ4	

Formal Assessment: How Does My Constellation Move?

At the start of the unit, students learn how different cultures have different stories represented as constellations. Students created their own story and constellation. After students view a simulation and see that constellations move around the sky over the year, they design an experiment to gather information on the movement and patterns of their constellation. Note: This is not a controlled experiment. Astronomers often gather data on stellar objects and then work to explain the patterns in their data. Using a simulated sky, such as Stellarium, students gather data on the position of their constellations over several years, using tools within the simulation to measure the position. Students plot the position of their constellation over time and create representations to show how the constellation moves and eventually moves back to the same position in the sky. Students analyze their data and use their data to answer questions about the motion of celestial objects and make connections to the Earth revolving around the sun.

Assessment Purpose and Use

- To assess students' ability related to interpreting data on the appearance of constellations in the sky.
- To determine if further support is needed relating to the identification of patterns in the visibility of constellations.

Administration Time: 30-45 minutes
Scoring Time: 15 minutes
Assessment Type(s)
Formal - Short Performance Task
Assessment Sub-Type(s)
Discussion prompts
Lab/Experiment
Scenario/Phenomena-based Assessment Task
Sample Instructionally-embedded Assessment Task: "How Does My Constellation Move?"

These assessments will assess students' ability to:

- Describe patterns in data to determine if some constellations are visible throughout the year.
- Represent data about the visibility of constellations to determine if some constellations are visible throughout the year.
- Use data to support conclusions about whether or not some constellations are visible throughout the year.
- Identify evidence that supports an explanation that some constellations are visible throughout the year.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• How Does My Constellation Move	5-ESS1-2	SL.5.5	EU2/EQ2	A17
			EU4/EQ4	A18

Formal Assessment: My Sun-Earth Model

Students finalize their model and explanation of how the Earth moves about the sun. Their final model is able to explain that the Earth rotates about on its axis as it revolves around the sun. Students use evidence from throughout the unit to support their model.

Assessment Purpose and Use

- To measure students' ability to engage in arguments to support a model and explanation of a phenomenon.
- To check students' understanding of the rotation and revolution of Earth and their ability to connect those ideas with evidence.

Administration Time: 30-40 minutes

Scoring Time: 15-20 minutes

Assessment Type(s)

Formal - Research Project

Assessment Sub-Type(s)

Extended Project

These assessments will assess students' ability to:

- Identify evidence that supports an explanation that the Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Construct an explanation that the Earth rotates about an axis and takes approximately 24 hours for a complete rotation.
- Identify evidence that supports an explanation that some constellations are visible throughout the year.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• My Sun-Earth Model	5-ESS1-2	SL.5.5	EU2/EQ2	A6
		MP.2	EU4/EQ4	A18
		MP.4		
		5.G.A.2		

Formal Assessment: Teaching About the Sun, Stars, and Earth

At the conclusion of the unit, students design an imaginary model of the Earth, sun, and stars that they would use to teach another 5th-grade student about apparent brightness (Segment 1), gravity (Segment 2), the rotation of the Earth (Segment 3), and the revolution of the Earth (Segment 4). Students are provided with a list of possible items to use. Students draw a plan of what their model would look like, adding labels and text where necessary, and write a paragraph explanation where they connect each part of their model with a real-world counterpart. In their explanation, they also explain how their model will support teaching others about each of the concepts.

Assessment Purpose and Use

- Identify student understanding of apparent brightness and apparent size, gravity, rotation and revolution.
- Identify student understanding of models used for explaining, how models connect to the real world, and limitations of models.

Administration Time: 30 minutes

Scoring Time: 10 minutes

Assessment Type(s)

Formal - Quiz

Assessment Sub-Type(s)

Design Project

These assessments will assess students' ability to:

- Develop and/or use a model to describe that light from stars reaches Earth even when those stars' distances vary greatly.
- Develop and/or use a model to describe that Earth rotates about an axis between its North and South poles and takes approximately 24 hours for a complete rotation.
- Use a model to describe that gravitational force can act at a distance even if objects are not in contact with each other.
- Engage in argument from evidence on why some constellations are visible at a location only at some part of the year.
- Support an argument that the gravitational force exerted by Earth on objects is directed down.
- Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):

- Where do the Stars go During the Day?
- Round and Down, but How?
- I'm Spinning Around
- My Sun Earth Model

NGSS PEs:	CCSS:	EUs/EQs:	AGs:
5-PS2-1	RI5.1	EU1/EQ1	A1
5-ESS1-1	RI.5.7	EU2/EQ2	A5
5-ESS1-2	RI.5.8	EU4/EQ4	A15
	RI.5.9		A18
	W.5.1		A19
			A20

Guidance for Equitable Assessments for Diverse Learners
How do we optimize accessibility for diverse learners and why is this important? The Guidance for Equitable Assessments for Diverse Learners provides steps to planning and developing equitable assessments that incorporate the principles of Universal Design for Learning (UDL) and the elements of Universally Designed Assessments (UDA). Both UDL and UDA are designed to provide access to instruction and/or assessment to the widest range of students. This includes, but is not limited to, students with varying abilities, cultures, primary languages, background knowledge, and interests. For more information about equitable assessment design and use, and why it is important, view *Chapter 4: Fairness and Accessibility* of the Strengthening Claims-based Interpretations and Uses of Local and Large-scale Science Assessment Scores (SCILLSS) Digital Workbook on Educational Assessment Design and Evaluation: Creating and Evaluating Effective Educational Assessments.
Assessment Resources
Segment 1 • Stellarium [https://stellarium-web.org] • Which of the Brightest Stars Is The Brightest? [https://docs.google.com/document/d/1hjUD_wcW07eN0pfLmYrQPy1rT_nrhvhSfDSyxEUxcxQ/template/preview] • Toilet Paper Solar System [https://greatbasinobservatory.org/lesson-plans/toilet-paper-solar-system-scale-model-0] **Segment 2** • Is The Earth Flat or Spherical? [https://docs.google.com/document/d/1O8eMbaWDU8uw8Rxz1ILIO4I__q9sJ4VGxYuHPMCYZNI/template/preview] • What Goes Up Must Come Down! [https://ngss.nsta.org/Resource.aspx?ResourceID=748] **Segment 3** • New Zealand Sunrise (no copyright) video [https://www.youtube.com/watch?v=o_kgdCGisso] • Nelson, Kara. Measuring Times as Earth Rotates and Revolves. Better Lesson. [https://teaching.betterlesson.com/lesson/636195/measuring-time-as-the-earth-rotates-and-revolves?from=cc_lesson] • Mutch, Jennifer. What Makes Day and Night. Better Lesson. [https://teaching.betterlesson.com/lesson/resource/3175695/day-and-night-worksheet] • Wonder Sci, Daily Patterns of a Hiking Stick Shadow [https://docs.google.com/document/d/1AEFCANfimNzSV3PhpZXNsn7zL7bdT4cFPGePpxK9OrA/template/preview] • NSTA Daily Do, Why is My Shadow Always Changing [https://my.nsta.org/collection/62130]

- Keely, Page, NSTA 2013, My Shadow Size
  [https://static1.squarespace.com/static/5f09c80930b545063d089cc6/t/604a42f58e715d7a4a58bfe9/1615479542627/ShadowSize+w+TNs.pdf]
- Carolina Curriculum, Tracking Shadows, Extended Activity
  [http://www.carolinacurriculum.com/premium_content/eBooks/Earth+Space/pdfs/Lesson_3.pdf]
- MySci Curriculum, My Place in the Universe, Earth, Orbits, Moon, Patterns, includes Q/A and student pages for sunrise, shadows, birthday daylight observations
  [https://content.schoolinsites.com/api/documents/32b1688a4d3e40b386f33d3cae4680f9.pdf]
- Tree Shadows
  [https://ngss.nsta.org/Resource.aspx?ResourceID=961]

Segment 4

- Kinesthetic Astronomy
  [https://www.spacescience.org/eduresources/kinesthetic.php]
- Wonder Sci, Paul Andersen, Tell Me Where was This Video Shot
  [https://docs.google.com/document/d/1AZr9y0fmjUKfPSuabxIeaHKeAPQmfLTw7rM_IWtfJzk/template/preview]
- Sun Tracks
  [https://ngss.nsta.org/Resource.aspx?ResourceID=799]
- Changing Constellations
  [https://my.nsta.org/resource/124051]
- Journey North Mystery Class
  [https://journeynorth.org/tm/mclass/indexCurrent.html]

Science
Grade: 5 Unit: 4
20 days of instruction

Stage 3 – Learning Plan

Learning Plan Rationale

The learning plan is based on an articulation of learning goals (i.e., NGSS PEs, CCSS, EUs/EQs, and acquisition goals (defined in Stage 1) distributed over four instructional segments. These learning goals are used in Stage 2 to identify and describe the assessments that will be used to assess (to collect evidence of) students' learning throughout the course of the unit and instruction. The lessons in Instructional Segments 1 through 4 are designed to ensure students have opportunities to acquire and apply the learning goals in Stage 1. The instructional segments in both Stage 2 and Stage 3 are similar in terms of the learning goals they represent. Assessments listed in Stage 2 for a segment might use (assess) fewer learning goals than are present in the respective Stage 3 but will not use additional learning goals (unless they were taught in a prior segment).

Unit Entrance

The unit opening focuses on students experiencing and discussing a phenomenon that sparks their interest and curiosity. To do so, the class engages with an "anchor phenomenon" and generates questions based on that phenomenon, posting their questions to the "driving question board." Some of the questions added to the driving question board can be used by the teacher to transition into Instructional Segment 1, by framing the lessons (and segment) as a means by which to investigate and answer some of the questions that students generate based on the anchor phenomenon.

Throughout the unit (e.g., at the conclusion of each instructional segment), the teacher returns to the driving question board while students reflect on their recent learning and which questions they can now answer based on their learning in the prior segment. Following this reflection, the teacher uses the driving question board again, this time identifying remaining unanswered (or partially answered) questions that can motivate the activities and investigations that will be the focus of the next instructional segment.

Anchor Phenomenon

In this unit, the anchor phenomenon is centered around observations of what is in the sky. As an example, the unit engages students with the astronomical studies of Indigenous cultures from around the world to encourage students to consider how different cultures engage with astronomy and the stars. The teacher can find a variety of resources online; one example of Indigenous astronomy can be found at Native Skywatchers. The teacher may also want to consider contacting local tribal agencies, tribal cultural departments, or intertribal agencies for localized information. Links to additional resources are also included in the materials at the end of the instructional framework.

Alternative anchoring phenomena can be selected by the teacher, such as having students "look up" outside to start their thinking and generate observations about that day's sun, moon, and/or their evening's stars, moon, and satellites/space station.

Unit Framing

Framing for SIPS Instructional Framework

Using constellations from diverse backgrounds as inspiration, students develop their own constellations and stories from their own local night sky. (Students may use a digital planetarium if they cannot go out after dark.) Students generate questions about their constellations, the sun, and the stars' apparent movements across the sky.

Example Driving Questions

Potential/example driving questions that students might generate, based on their observations of this anchor phenomenon include:

- Why is the sky different for different communities around the world?
- Why don't we fall off the Earth?
- Why doesn't the moon fall to Earth?
- Which way is "down"? At which point does "down" become "up"?
- How does the Earth move? What causes day and night?
- What causes shadows?
- What causes the stars and moon to shine?
- If there are stars, why don't we see them during the day?

Potential Investigative Phenomena (Scaffolded by having a Common Point of Exploration)

- Shadows changing over a day
- Stars moving across the sky in a circular pattern (star trails)
- The changing of the length of day over a school year
- Two objects being dropped in a vacuum falling at the same rate (coin and feather)
- The moon, Earth, and sun being spherical
- The Earth's location in the solar system and the galaxy
- 3-dimensional view of constellations
- Objects appearing larger or smaller than each other because of their relative positions
- The moon in the sky during the day
- Sundials
- Eclipses
- Space jumping (Felix Baumgartner)
- Ancient astronomical tools such as Stonehenge
- Meteorites falling to Earth

Instructional Segment 1

Learning Investigations and Sample Lessons

Alignment Coding	
NGSS PEs: **5-ESS1-1** **CCSS:** **MP.2** **MP.4**	**Estimated Classroom Time: 250 minutes** **Stories in the Sky** • 5Es: Engage • Estimated Time: 50 minutes • AGs: A5*, A17*, A18*

5.G.A.2 **SL.5.5** **EUs/EQs:** **EU2/EQ2** **EU4/EQ4** **AGs:** **A1** **A2** **A3** **A4** **A5*** **A17*** **A18*** **A20**	The teacher begins by asking students to share what they know about constellations and if they know of any. The teacher encourages students to share their thinking and any constellations they know of, making a list on the board. The teacher share with students the story, “Relearning the Star Stories of Indigenous Peoples” from Science Friday. There is an audio clip of the news story which students can listen to as they read along in the article, with images to support their learning. After listening to the story, the teacher encourages students to share their takeaways and encourages them to consider, “What does it mean for different cultures to have different constellations?” To help students better picture the different ways of looking at the sky, the teacher shares with them some examples of star maps from different cultures, such as those found at https://annettelee.com/index.php/portfolio/star-maps/ and asks them to share what they notice. How are they alike? How are they different? What do they notice about the overlaps? Next, the teacher encourages students to generate questions they have about the sky and different ways that cultures see the sky. The teacher begins to generate a driving question board based on the students’ questions. After students generate some questions, the teacher shares with the students that they will be learning about the sky over the unit with a focus on what they observe in the sky. The teacher encourages students to consider what kinds of observations we need to make to better understand the sky and what we see. What kind of objects are there in the sky, and what should we focus on to start? Students complete the sky observation portion *My Sky, My Story*. The next day in class, students use Stellarium to observe their constellation in the sky, make observations about the movement, and generate additional questions. The class discusses the questions that students have and adds them to the driving question board. **The Sun and Stars** • 5Es: Explore, Elaborate • Estimated Time: 75 minutes • AGs: A1*, A2*, A3, A4 Students explore a variety of resources to learn about stars and the sun. Using core curricular materials and supplements suggested in the core text connections and instructional resources, students gather information and record their learning in their science notebook or other organizer. To support students’ research and focus, the teacher may want to provide curated resources grouped by topic or by sub-questions. Potential topics/sub-questions include: • What is a star made of? • Why are some stars brighter than others? • Which star is closest? Is it the brightest? • How far away are the stars?

	• How can we see the stars? • What kinds of telescopes do we use to see the stars? • Why are telescopes bigger or smaller? • What is the sun? • How is the sun different from other stars? How is it alike? • How far away is the sun? How does that compare to other stars? Next, students prepare a presentation that includes an explanation and their understanding of the distance of the sun from Earth relative to other stars. After students gather their information, they meet with other groups to share and collaborate on what they found and why they think their information is important. After students have finished their collaboration, the teacher shares with them an article on the topic of light pollution from satellites, such as Picture imperfect: light pollution from satellites is becoming an existential threat to astronomy | Astronomy | The Guardian or Elon Musk's Starlink satellites are interfering with astronomy. It's just the beginning. - Vox. The 2nd article has a number of simulations embedded in it to view as well. The class discusses the article and the impacts of satellites on the night sky. **Big, Small, it is all Relative** • 5Es: Explore • Estimated Time: 75 minutes • AGs: A2, A3, A4* Students watch the video Forced Perspective. The teacher pauses the video at 7 seconds. Students are asked to rank objects from tallest to shortest: painting, man, ball, cup 1, cup 2, and a chair. Students watch the remainder of the video to see that, because of the relationship between apparent size and the actual size of an object, things are not always as they appear. To see this quantitatively, students gather data that includes graphical displays about the apparent size of a basketball, a baseball, or some other objects. After placing the students in small groups, the teacher provides them with a ruler and a measuring tape. The teacher places the two balls next to each other and students stand at different distances away from the balls and record measurements of how large the ball appears to be using the ruler. Students examine their data to see what patterns they notice, noticing that the closer they are to the objects the larger they appear to be. (It is well above grade level for students to find the mathematical relationship between apparent size and distance. The focus instead is on the idea that as they get closer the object appears larger.) The teacher encourages them to consider how they would arrange the two objects so that they were the same size and how to make the smaller object appear larger. To understand how brightness is impacted by distance, students collect data using a light meter and measure the change in brightness at different distances from a light source, similar to the science project Star light, Star bright: How Does Light Intensity Change with Distance?. In this activity, students use a light meter or light meter app on a

	smartphone/tablet to measure how bright a light source is at different distances. Students create graphs of their data and find that brightness drops off significantly as they move away from the source (Inverse Square Law, note: the mathematical relationship is above grade level but could be an opportunity for advanced students.) After students have created their graphs, the class discusses what the graph means for brightness. The teacher uses questioning strategies to support students in recognizing that brightness decreases rapidly as we move away from an object before slowing down. The teacher shows the initial video again to students, pausing at 7 sec again. Students create an annotated drawing that uses evidence, logic, and reasoning to explain the apparent sizes of the different objects which includes drawings, labels, explanatory text, and other representations that they feel are appropriate. **Sample Lesson:** “Big, Small, it is all Relative” **Where do the Stars go During the Day?** • Explain, Evaluate • Estimated Time: 50 minutes • AGs: A1, A2, A20 The teacher places a short string of holiday lights up in the classroom for students, enough lights that they could be seen with the class lights on, but not overpowering. The teacher set the classroom lights to be bright so that they overpower the string lights. Before turning on the string lights, students consider what they think happens if there is one very bright object and many smaller, less bright objects. The teacher provides students time to reflect on the prompt and then turn and talk about what they think would happen. The teacher turns off the classroom lights and then turns on the string of lights. The teacher asks students what they notice about the string (it’s bright, it’s easy to see, etc.). The teacher turns on the classroom lights while leaving the string of lights on so that the string of lights is overpowered. The teacher asks the students what they notice about the string now (it is still on, but not as bright, it is harder to see). The teacher explains to students how this is a simple model of the night sky, and it is missing some important elements that they learned about. Students draw a modified version of this model that will better model what they have learned about the night sky and create a scientific explanation for why the sun is bigger and brighter than other stars.
Instructional Segment 2	
Learning Investigations and Sample Lessons	
Alignment Coding **NGSS PEs:** **5-PS2-1** **CCSS:** **RI.5.1** **RI.5.7**	**Estimated Classroom Time: 275 minutes** **Why Are Stars and Planets, like Earth, Round?** • 5Es: Engage • Estimated Time: 75 minutes • AGs: A11, A12, A14, A15, A19* The teacher begins class with a variety of images of stars and planets from our solar system displayed for students. The teacher asks students, “What do you notice is the same about

RI.5.8 **W.5.1** **SL.5.5** **EUs/EQs:** **EU1/EQ1** **EU3/EQ3** **EU4/EQ4** **AGs:** **A11** **A12** **A13** **A14** **A15** **A19**	all of these objects?" The teacher uses wait time and encourages students to discuss the question, sharing what they notice. If students do not notice it, the teacher uses questioning to draw their attention to the shape of the objects. Then, the teacher poses to the students, "Why are stars and planets shaped like spheres (round)?". The class generates questions that they may have related to this phenomenon. To introduce the topic of gravity, students conduct an investigation where they drop a variety of items. The items should avoid shapes/textures that could drift/blow due to surface area and air resistance such as wide papers, cloth, and feathers. The items can be dropped in "races" in sets of 2 similar shapes and sizes, yet different weights of items, such as whiffle ball and tennis ball, pencil and bolt, penny and plastic counter, or marble and Styrofoam packing pellets. Students measure the weight/mass of each object and record observations about the motion of the objects, being sure to include what they notice about how they fall and how they land. The class reviews the features of an annotated drawing. Then, the class discusses what should be represented in this particular annotated drawing. The teacher may need to use questions to help guide students toward recognizing that they may want to use lines to represent motion, arrows to indicate a push or pull on an object, and labels. Students draw an annotated drawing in which they draw objects falling and write a short explanation of what they think is occurring, being sure to include that objects with different weights/masses landed at the same time. As a homework assignment, students go on a "gravity scavenger hunt." Using cameras, phones, or through drawings, students explore the world around them and find examples of objects falling or being pulled down such as on playground equipment, pendulums, leaves/acorns/nuts falling, etc. After identifying at least 5 examples, students write down what they notice is the same between each different observation. **Which Way is Down?** • 5Es: Explore • Estimated Time: 50 minutes • AGs: A11, A12, A14, A15, A19* To investigate the direction of gravity, students conduct an investigation where they use string to hang an object, such as a nut from a hardware store, from the center of a meter stick. First, students position the meter stick between two desks, measure the angle 5 times, and then average the measurement. Students record their observations in a common place and then as a class examine the data. Students notice that the results are all around 90 degrees, or close to straight down. Students go out in the school and grounds, as allowed, to gather additional data to see if the results hold true. The teacher reminds students that it's important that the meter stick is level. As an alternative, the teacher may want to go out and set up the apparatus at a variety of locations and take photos. Students can use the protractor to make measurements on the photos instead. Depending on the location, the teacher may want to take a photo on sloped locations, such as a hillside, being sure to set up the apparatus so that it is level with the horizon. A

	situation like this would provide evidence that gravity is not straight towards the surface, but towards the center of the Earth, straight down. Students record their observations in their notebooks, as well as evidence from the activity about the direction of the pull on objects. **Round and Down, but How?** • 5Es: Explore, Explain • Estimated Time: 75 minutes • AGs: A11, A13, A15 The class comes together to discuss how everything falling toward the Earth is related to why the Earth is round. Using core curricular materials and core text and instructional resources from the end of this instructional framework, the teacher facilitates learning about the concept of "gravity" an attractive force that pulls everything together. As students watch, read, and explore resources, they record information about gravity in their scientific notebooks, graphic organizers, or concept maps. After exploring content related to gravity, students review additional material about the Earth, evidence that the Earth is round, and why astronomical objects are round. The teacher encourages students to consider how gravity's nature helps to explain why the Earth is round. **Gravity Brings Us All Together** • 5Es: Explain, Evaluate • Estimated Time: 50 minutes • AGs: A11, A19 The teacher presents to students the scenario where they have a friend from another school who thinks that the Earth is flat. The teacher asks the students to create a presentation or write an explanation in which they explain that the Earth is round and that gravity pulls us towards the center, using evidence from this unit and any other prior learning. **Traveling Beyond Earth, Looks Don't Change but Weights Sure Do!** • 5Es: Elaborate • Estimated Time: 25 minutes • AGs: A14 The teacher poses for students, "What do you think it is like to walk on the moon? Do you think it is easy or hard? Why do you think that?" The teacher encourages students to share their thinking and then shows them a video of a student using a moon walk simulator, Space Camp: Moon Walk Simulator. After watching the video, the class discusses what they noticed about the child in the simulator and what it would be like to walk on another planet or moon. Next, students use pennies as the weight of a soda can on different planets and the moon to assemble a model of those weights. In the model, an empty soda can represent its weight on Earth. Students measure the mass of a soda can using pennies/washers on a balance, then use the Exploratorium Simulation "The Weight in Other Worlds." to find what a can would weigh on different worlds. They use pennies to create physical bar

<table>
<tr><td></td><td>graphs of their data and then graph their data. Students can also be provided the challenge of finding their own way of representing data in a creative way.</td></tr>
<tr><td colspan="2">Instructional Segment 3</td></tr>
<tr><td colspan="2">Learning Investigations and Sample Lessons</td></tr>
<tr><td>Alignment Coding
NGSS PEs:
5-ESS1-2
CCSS:
MP.2
W.5.1
SL.5.5
RI.5.7
EUs/EQs:
EU2/EQ2
EU3/EQ3
EU4/EQ4
AGs:
A3
A5
A6
A7
A8
A9
A10
A15</td><td>Estimated Classroom Time: 245 minutes
What Have We Seen So Far?
• 5Es: Engage
• Estimated Time: 25 minutes
• AGs: A3, A5*, A6*, A8*, A15*
The teacher opens class with a display of an image of the sky during the daytime with the sun and moon in the sky and visible in the picture. The teacher poses to students the question for them to consider about the motion of the sun across the sky such as, “How can we explain the movement of the sun, stars, and moon in our sky using a model?” Students are given time to reflect on their thinking and talk with a partner to review their observations from their Sky Journal. The class discusses what students observe about the sun at different times of the day. Students create a table and an annotated drawing of what they have observed about the sun’s position at different times of day. Students annotated drawings show that the sun moves across the sky as the day advances. Students are provided with crafting resources such as wire, foam balls of differing sizes, pins, adhesive labels, and others. The teacher asks the students to create a model of the Earth and sun that explains why we have day and night, and why the sun moves across the sky.
Students build their models and then draw a picture of the model. They write scientific explanations that explain, using their prior knowledge, how the sun and Earth move relative to each other, using their models and drawings to support their thinking.
Why are Shadows Always Changing?
• 5Es: Explore, Explain
• Estimated Time: 75 minutes, and three 5-minute observation sessions throughout the day to measure shadows.
• AGs: A9, A10
Students investigate shadows in which they observe changes in shadows and the sun’s position over the day. As students collect data, they begin to recognize the cause-and-effect relationship between the changing position of the sun, causing the shadows to change. Using Delta Education: Shadows Change Places Over the Day as a model for teacher instruction, students go outside and observe that shadows change over time. They record the changes in a shadow’s length and direction from morning to midday to afternoon and recognize that most shadow changes are caused by changes in the position of the sun. Next, using Delta Education: Shadows Long and Short as a model for teaching instruction, students move beyond observing to conduct an investigation with a flashlight and objects. Students organize their data sets from the experiment into a graphical display that shows changes in length and direction of a shadow over their experimental time. After</td></tr>
</table>

	the experiments, students can watch the reference video Crash Course Kids: Following the Sun to identify additional evidence to support their explanations about what causes the changes in shadows. **Why do we have Time Zones?** • 5Es: Explore, Explain • Estimated Time: 25 minutes • AGs: A5, A6*, A7, A8 The teacher displays for students a map of the world which shows the time zones, such as Time Zone Map. The teacher asks the students, "What do you know about time zones?" and facilitates a short discussion about what they know about time zones before asking them, "Why do we have time zones on Earth?" Instead of having them answer this question, the teacher tells students that they are going to collect some information about different places on Earth related to the sun to see if they can better understand why there are time zones. The teacher displays for students a flat projection of a map of the world and a globe. Students use Stellarium to observe the sky at different points around the world, making sure they look at the current time. (There is an icon on the time controls to set it to the current time.) As students make observations, they come up to the map and the globe and mark if it is night, day, or somewhere in between. The teacher provides stickers, pins, or some method to mark this on the globe or map to students. The teacher encourages students to keep adding location observations until they can start to see a pattern. Eventually, students have enough observation points to represent on the maps that when the sun is high in the sky on one side of the world, it is dark on the other, with dawn and dusk occurring in between. Students create an annotated drawing of the globe or map with labels that indicate where it is day, night, and in between. The teacher encourages them to use shading and colors to show the amount of light around the world. The teacher asks students to answer the question, "Why do we have time zones?" as an exit ticket to check for their understanding that time zones are necessary because day and night occur at different times around the world. **I'm Spinning Around** • 5Es: Explore, Evaluate • Estimated Time: 25 minutes • AGs: A5, A6, A8 Before starting the next activity, if possible, the teacher hangs or adheres stars or objects on the classroom ceiling. The class watches the video YouTube: North Star (Star Trails), and the teacher explains to students that what they are seeing is an animation that is the result of pictures being taken with a special camera of the sky looking up at Polaris, the North Star. The teacher pauses the video at 0:30 and students write down what they notice. The teacher continues the video and pauses again at 0:43, and students write down what they notice. The teacher allows the video to play out and after finishing the video, students write down what they notice. The teacher asks the students, "What do you think this

	means, and how does this relate to our model?" The class discusses what students think it means. The teacher places a chair that can rotate, like an office desk chair, directly under the stars hung from the ceiling. A student sits in the chair and asks them to move without standing in such a way that the stars on the ceiling turn like they saw in the video. The other students observe their movements. At this point, students have enough evidence and experience to understand that the Earth rotates, like the person in the chair. The teacher facilitates a class discussion where students discuss the meaning of the person rotating, the rotating sky, and the differences in sunlight around the world. The teacher uses questioning strategies to support students as they work through this concept and potentially build new understanding. The teacher avoids telling students what the evidence means but uses questions to support them as they come to an understanding. After the class discussion, students return to their model and explanation and revise it to incorporate their new understanding that the Earth rotates on an axis. Once students have revised their model, they share their model with peers and provide each other feedback on their models. **Time by the Ancient Sundial** • 5Es: Explore, Elaborate • Estimated Time: 50 minutes, with hourly observations about 5 minutes in length (30 minutes). • AGs: A9, A10 Students create a sundial to investigate shadows, observe the movement of the sun, make quantitative observations, collect data, and recognize the patterns. Students design and construct sundials using the engineering design process. Alternatively, students use the template in the resources. On a sunny day, students set up their sundial outside in the morning in a flat spot. Students measure the length of their shadow, the time of day, and use a compass to measure the angle of the shadow. Students create a chart to record their data hourly. Based on the data they collected, students answer the following questions: What is the path of the sun as it moves across the sky? Does the sun's path across the sky and the pattern of the shadows change during the day?
Instructional Segment 4	
Learning Investigations and Sample Lessons	
Alignment Coding **NGSS PEs:** **5-ESS1-2** **CCSS:** **SL5.5** **W.5.1**	**Estimated Classroom Time 225 minutes** **Does Spinning Explain Why My Constellation Moves?** • 5Es: Engage • Estimated Time: 25 minutes • AGs: A17, A18* The teacher asks the students, "Can you explain the movement of your constellation by the spinning of the Earth?" The teacher encourages students to turn and talk about the

MP.2 **MP.4** **EUs/EQs:** **EU2/EQ2** **EU3/EQ3** **EU4/EQ4** **AGs:** **A16** **A17** **A18**	evidence and information they learned about the Earth's rotation and return to Stellarium to watch the constellation's movement over a day and over several months to a year. Students see that the constellation may rotate in the sky over a day, but it doesn't explain the movement over the entire year, with constellations rising and falling below the horizon. The class revisits the driving question board to see what questions may help explain this phenomenon and record any new questions for the driving question board. **Daytime, Nighttime, Playtime, Bedtime!** • 5Es: Explore, Explain • Estimated Time: 75 minutes and time weekly throughout the year to record sunrise and sunset times. • AGs: A16, A18* The teacher starts the lesson by reminding students that we can see our constellations rotate in the sky with it repeating every 24 hours, but it also moves from month to month. How long does it take for our constellation to move below the horizon or across the sky and come back to its same spot? If students do not recall that it takes about 1 year, the teacher demonstrates using Stellarium if students need a reminder that it takes about 1 year for it to be back in the same spot. The teacher reminds students, "We saw how the sun's movement across the sky took 24 hours, and how that was because of the Earth rotating. Today we are going to look for other patterns in the sky to see if we can find any others that take around a year to repeat." Students research, analyze, and graph data sets of times of sunrise, sunset, daylight, and dark to recognize patterns of these events and changing conditions. Because students have been participating in a class activity to develop a long-term data set over the span of the school year (*Schoolyear Sky Journal*) they have some local data to work with. Students create a graphical representation of the data over the year. The teacher uses Stellarium to gather data from before or after the school year to complete the data set. To emphasize the contrast around the Earth, students examine a globe to identify multiple locations around the Earth. The teacher divides the class into groups and each group gathers data on their assigned location using a tool such as Stellarium, where they can directly observe the sunrise/sunset by rapidly advancing the time or using data provided at one of the sources below. After collecting and analyzing their data, students create a graphical or illustrative display as evidence of understanding the different levels of light for a location over a year. The contrast research allows students to apply their understanding of the Earth's rotation and pattern of light/dark to another location outside of their immediate lives. Additional data sets can be found at Sunrise and Sunset Calculator for Towns, the more complicated National Weather Service and Sunrise Sunset Information Site, or NOAA's Solar Calculator. After their data analysis, students create a visual display to show how sunrise and sunset change over a year for their location. Students display their data around the room and then walk around the room to identify any patterns. Students return to their model to ask the question, "Does my model explain the different times for sunrise and sunset?"

Students work in their small groups to consider how they should change their model to fit this new information, make revisions, and support those changes with evidence. As they work on making revisions, the teacher uses guiding questions to support students.

How Does My Constellation Move?

- 5Es: Explore
- Estimated Time: 75 minutes
- AGs: A17, A18*

Students chart how their constellations move.

In this activity, students conduct an investigation to gather data about how their star moves in the sky and how they can chart it out using Stellarium. Students use the azimuthal grid to plot lines across the sky. The teacher shows students how in between each direction (N, S, E, W) there are 6 boxes in each row, with 4 rows up and 4 rows down (removing the landscape so students can see below the horizon). Students plot the location of stars on sheets of grid paper, connecting the dots to help show the movement of the stars around the sky.

Students analyze the data they have collected and answer discussion questions that help to guide them to see that every year the constellations have returned to the same place.

Next, the teacher places a basketball or other object in the center of the classroom, gymnasium, or open area to represent the sun. Then, students stand in a circle around the ball; they will represent Earth. The teacher asks students, “If we were observing the stars, where would the sun be?” (behind us). Students turn so the sun is at their back, with their hands left and right of their eyes (limits their peripheral view). Students draw a picture of what they see directly in front of them. Next, students turn to face the person to their right, so they are all facing the back of someone in a circle. (It may help to mark out a circle on the floor.) Students take several steps around the circle, about ¼ of the way. Students turn with their back to the “sun” and make another observation and drawing. The class repeats these three more times, so the last observation is at the same location as the first.

The teacher facilitates a class discussion about the evidence collected during this learning investigation. As students discuss, the teacher uses prompts to help students recognize that the constellations change over a year, but repeat, and that this is similar to what they saw when revolving around the “sun.”

Sample Lesson: “How Does My Constellation Move?”

My Sun-Earth Model

- 5Es: Explain, Evaluate
- Estimated Time: 25 minutes
- AGs: A16*, A17*, A18

Students return to their model of the sun and Earth and modify their model and explanation to incorporate the evidence that the Earth revolves around the sun while rotating. Students make changes and share their thinking with peers who give them feedback before finalizing their model.

Universe In a Box

	5Es: Elaborate, Explain - Estimated Time: 25 minutes - AGs: A18*, A20 The teacher challenges students to create a "universe in a box" similar to the Mystery Science: Universe In A Box. Instead of providing the students with the template with constellations already drawn, students create their own universe in a box. Students draw their own constellations on the inside of the box and build a box in a similar manner. This could be done on paper as the website has done, or it could be done in a small square box. After completing their simple model of the sky, students write an explanation where they explain the strengths and weaknesses of their model.

Accessibility and Differentiation for Diverse Learners

"Universal Design for Learning (UDL) is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn" (CAST, 2022). Taking time to reflect on prior instruction when planning for accessible, differentiated, and culturally responsive instruction for diverse learners and culturally diverse classrooms serves to identify ways to improve future instructional practices. The UDL Guidelines provide a framework for this reflection. The guidelines include three principles, Multiple Means of Engagement, Multiple Means of of Representation, and Multiple Means of Action & Expression as ways to focus on variety and flexibility in instructional practices. By examining instruction and instructional materials through the lens of each of these principles, we can identify and thus reduce or remove barriers to diverse learners.

Providing Multiple Means of Engagement (e.g., allowing choices, authentic scenarios, varying demands, clear goals), broadens the opportunities of gaining and sustaining students' interest and cognitive engagement in learning the content. Providing Multiple Means of Representation (e.g., variety of presentation modes, clarifying vocabulary, activate background knowledge) allows for students to receive and comprehend the content. Providing Multiple Means of Action & Expression (e.g., variety of methods to respond to instruction, variety of ways to interact with the instructional materials) helps students to use their strengths and abilities to access the instructional materials and express what they understand. Accommodations are typically reserved for students receiving special education, students who have a 504 plan, and English Learners can be made available to all students using the UDL principles, thus allowing all students to benefit from the accommodations.

The SIPS Grade 5 Unit 4 Instructional Framework Differentiation Strategies and Resources support educators' intentional planning of accessible, differentiated, and culturally responsive instruction for all students aligned to the specific performance expectations in focus for this unit.

Core Text Connections

- "Relearning the Star Stories of Indigenous Peoples" from Science Friday
  [https://www.sciencefriday.com/articles/indigenous-peoples-astronomy/]
- The Guardian: Picture Imperfect
  [https://www.theguardian.com/science/2023/jan/06/picture-imperfect-light-pollution-from-satellites-is-becoming-an-existential-threat-to-astronomy]
- Vox: The Night Sky is Increasingly Dystopian

[https://www.vox.com/science-and-health/2020/1/7/21003272/space-x-starlink-astronomy-light-pollution]

- The Wonder of Science: Forced Perspective
  [https://thewonderofscience.com/phenomenon/2018/7/5/forced-perspective]
- Crash Course Kids: Following the Sun
  [https://youtu.be/1SN1BOpLZAs]
- Science Trek: Gravity
  [https://www.pbs.org/video/gravity-m3swlv/]
- Exploratorium: "The Weight in Other Worlds."
  [https://www.exploratorium.edu/explore/solar-system/weight
- PBS Space Time: Why is The Earth Round and Milky Way Flat?
  [https://www.pbs.org/video/pbs-space-time-earth-round/]
- Science Trek: How To Tell The Earth is Round
  [https://www.pbs.org/video/astronomy-how-tell-earth-round-yiilth/]
- PBS Newshour: 7 DIY Experiments you and Rapper B.o.B. can do to Prove Earth is Round
  [https://www.pbs.org/newshour/science/7-diy-experiments-b-o-b-the-earth-is-round]
- Minutephysics: Top 10 Reasons Why We Know the Earth is Round
  [https://youtu.be/o_W280R_Jt8]
- Lowe, S. (2015). Cosmos: The infographic book of space.
  [https://www.amazon.com/Cosmos-Infographic-Space-Stuart-Lowe/dp/1781316457]
- Sisson, S. (2014). Star stuff: Carl Sagan and the mysteries of the cosmos.
  [https://www.amazon.com/Star-Stuff-Sagan-Mysteries-Cosmos/dp/1596439602]
- Simon, S. (1989). The sun.
  [https://www.amazon.com/Sun-Rise-Shine-Seymour-Simon/dp/0688092365]
- Bailey, J. (2004). Sun up, sun down: The story of day and night.
  [https://www.amazon.com/Sun-Up-Down-Story-Science/dp/1404811281]
- PBS: Stars, Constellations and Planets | Young Explorers
  [https://dptv.pbslearningmedia.org/resource/stars-constellations-and-planets-video/young-explorers/]
- PBS: Why do Stars Twinkle and Move? | Ask MIT
  [https://dptv.pbslearningmedia.org/resource/stars-twinkle-move/stars-twinkle-move/]
- PBS: SciGirls | Star Power (brightness)
  [https://dptv.pbslearningmedia.org/resource/d37c7694-5bc7-4d2e-a6cf-786f3b780536/star-power/]
- PBS: Scientist Profile: Galactic Astronomer
  [https://dptv.pbslearningmedia.org/resource/42e050ec-e853-42da-bb1c-4b18f07cd300/42e050ec-e853-42da-bb1c-4b18f07cd300/]
- PBS Nature Cat: A Perfect Night for Stargazing (review resource for students new to stargazing)
  [https://dptv.pbslearningmedia.org/resource/nature_cat_stargazers/nature-cat-stargazers/]

- eduMedia: Astronomy Simulations (subscription required for full access) [https://www.edumedia-sciences.com/en/node/347-earth-moon-and-sun]
- University of Nebraska: Lunar Phase Simulator [https://ccnmtl.github.io/astro-simulations/lunar-phase-simulator/]
- University of Nebraska: Motion of the Sun Simulator [https://ccnmtl.github.io/astro-simulations/sun-motion-simulator/]
- University of Nebraska: Daylight Simulator [http://astro.unl.edu/classaction/animations/coordsmotion/daylightsimulator.html]
- University of Nebraska: Sun's Position on Horizon Simulation [http://astro.unl.edu/classaction/animations/coordsmotion/horizon.html]

Instructional Resources

Stage 3 Instructional Resources:

- Exploritorium: Outdoor Shadows [https://www.exploratorium.edu/snacks/outdoor-shadows]
- Better Lesson: Constellations are Seasonal [https://teaching.betterlesson.com/lesson/639841/constellations-are-seasonal]
- Stellarium [https://stellarium-web.org]
- NASA: Legends in the Sky [https://nightsky.jpl.nasa.gov/docs/LegendsDraftApril2020.pdf]
- PBS: At Home Astronomy: How You Can Observe the Night Sky | STEM in 30 [https://dptv.pbslearningmedia.org/resource/at-home-astronomy-video/stem-in-30/]
- Sloan Digital Sky Survey: Constellations Activity [https://skyserver.sdss.org/dr16/en/proj/kids/kidshome.aspx]
- Native Skywatchers: Resources [https://www.nativeskywatchers.com/resources.html]
- Mystery Science: Universe In A Box [https://mysteryscience.com/astronomy/mystery-4/seasonal-patterns-earth-s-orbit/75#slide-id-0]
- Sunrise and Sunset Calculator for Towns, [https://www.timeanddate.com/sun/]
- National Weather Service and Sunrise Sunset Information Site, [https://www.weather.gov/mrx/sr_ss]
- NOAA's Solar Calculator [https://gml.noaa.gov/grad/solcalc/]
- YouTube: North Star (Star Trails) [https://youtu.be/tp6UkqIwVfk]
- Delta Education: Shadows Change Places Over the Day

[https://youtu.be/FWFh3kAt-BY]

- Delta Education: Shadows Long and Short
  [https://youtu.be/wB6V7BCSMfg]
- Star light, Star bright: How Does Light Intensity Change with Distance?
  [https://www.sciencebuddies.org/science-fair-projects/project-ideas/Astro_p034/astronomy/how-does-light-intensity-change-with-distance]