Grade 5 Science, Unit 6

Interactions Within the Earth, Sun, and Moon System

Overview

Unit abstract

In this unit of study, students are expected to develop an understanding of patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. The crosscutting concepts of patterns, cause and effect, and scale, proportion, and quantity are called out as organizing concepts for these disciplinary core ideas. In the fifth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in analyzing and interpreting data and engaging in argument from evidence. They are expected to use these practices to demonstrate an understanding of the core ideas.

Essential questions

- How do lengths and directions of shadows or relative lengths of day and night change from day to day?
- How does the appearance of some stars change in different seasons?

Bristol–Warren, Central Falls, Cranston, Tiverton, and Woonsocket, with process support from The Charles A. Dana Center at the University of Texas at Austin

Written Curriculum

Next Generation Science Standards

5. Space Systems: Stars and the Solar System

Students who demonstrate understanding can:

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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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)	**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)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1)

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels: **3.PS2.A** (5-PS2-1); **3.PS2.B** (5-PS2-1); **MS.PS2.B** (5-PS2-1)**; MS.ESS1.B** (5-PS2-1); **MS.ESS2.C** (5-PS2-1)

Common Core State Standards Connections:

ELA/Literacy –

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)*

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)

W.5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-PS2-1)

5. Space Systems: Stars and the Solar System

Students who demonstrate understanding can:

5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from 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).]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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-ESS1-1)	**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)	**Scale, Proportion, and Quantity** ▪ Natural objects exist from the very small to the immensely large. (5-ESS1-1)

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels: **MS.ESS1.A** (5-ESS1-1)**; MS.ESS1.B** (5-ESS1-1)

Common Core State Standards Connections:

ELA/Literacy –

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(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-ESS1-1)

W.5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-ESS1-1)

Mathematics –

MP.2 Reason abstractly and quantitatively. *(5-ESS1-1)*

MP.4 Model with mathematics. *(5-ESS1-1)*

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)*

5. Space Systems: Stars and the Solar System

Students who demonstrate understanding can:

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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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)	**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)	**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)

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels: **1.ESS1.A** (5-ESS1-2); **1.ESS1.B** (5-ESS1-2); **3.PS2.A** (5-ESS1-2); **MS.ESS1.A** (5-ESS1-2)**; MS.ESS1.B** (5-ESS1-2)

Common Core State Standards Connections:

ELA/Literacy –

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)*

Mathematics –

MP.2 Reason abstractly and quantitatively. (5-ESS1-2)

MP.4 Model with mathematics. (5-ESS1-2)

5.G.A.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS1-2)

Clarifying the standards

Prior learning

The following disciplinary core ideas are prior learning for the concepts in this unit of study.

By the end of Grade 1, students know that:

- Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.
- Seasonal patterns of sunrise and sunset can be observed, described, and predicted.

By the end of Grade 3, students know that:

- Each force acts on one particular object and has both a strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative, addition of forces is used at this level.)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)
- Objects in contact exert forces on each other
- Electrical and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.

Progression of current learning

Driving question 1
What effect does Earth's gravitational force have on objects?

Concepts	Practices
• Cause-and-effect relationships are routinely identified and used to explain change. • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	• Identify cause-and-effect relationships in order to explain change. • Support an argument with evidence, data, or a model. • Support an argument that the gravitational force exerted by Earth on objects is directed down. ("Down" is a local description of the direction that points toward the center of the spherical Earth.) (Assessment does not include mathematical representation of gravitational force.).

Driving question 2
What effect does the relative distance from Earth have on the apparent brightness of the sun and other stars?

Concepts	Practices
• Natural objects exist from the very small to the immensely large. • 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.	• Support an argument with evidence, data, or a model. • Support an argument that differences in the apparent brightness of the sun compared to that of other stars is due to their relative distances from Earth. (Assessment is limited to relative distances, not sizes, of stars, and does not include other factors that affect apparent brightness, such as stellar masses, age, or stage.).

Driving question 3
What patterns can be observed in the daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky?

Concepts	Practices
• Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena. • 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, – Different positions of the sun, moon, and stars at different times of the day, month, and year.	• Sort, classify, communicate, and analyze simple rates of change for natural phenomena using similarities and differences in patterns. • Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. • 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. (Assessment does not include causes of seasons.) Examples of patterns could include: – The position and motion of Earth with respect to the sun; – Selected stars that are visible only in particular months.

Integration of content, practices, and crosscutting concepts

In this unit of study, students explore the effects of gravity and determine the effect that relative distance has on the apparent brightness of stars. They also collect and analyze data in order to describe patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

To begin the progression of learning in this unit, students explore the effects of gravity by holding up and releasing a variety of objects from a variety of heights and locations. Students should record and use their

observations to describe the interaction that occurs between each object and the Earth. In addition, students should use their observations as evidence to support an argument that the gravitational force exerted by the Earth on objects is directed "down" (towards the center of the Earth), no matter the height or location from which an object is released.

Next, students investigate the effect of distance on the apparent brightness of stars. Using information from a variety of print or digital sources, students learn that natural objects vary in size, from very small to immensely large. Stars, which vary in size, also range greatly in their distance from the Earth. The sun, which is also a star, is much, much closer to the Earth than any other star in the universe. Once students understand these concepts, they should explore the effect of distance on the apparent brightness of the sun in relation to other stars. This can be accomplished by modeling the effect using a light source, such as a bright flashlight. As students vary the distance of the light from their eyes, they should notice that the farther away the light is, the less bright it appears. Observations should again be recorded and used as evidence to support the argument that the differences in the apparent brightness of the sun compared to that of other stars is due to their relative distances from the Earth.

To continue the progression of learning, students investigate the following observable patterns of change that occur due to the position and motion of the Earth, sun, moon, and stars.

- Day and night—This pattern of change is a daily, cyclical pattern that occurs due to the rotation of the Earth every 24 hours. Students can observe model simulations using online or digital resources, or they can create models in class of the day/night pattern caused by the daily rotation of the Earth.
- The length and direction of shadows—These two interrelated patterns of change are daily, cyclical patterns that can be observed and described through direct observation. Students need the opportunity to observe a stationary object at chosen intervals throughout the day and across a few days. They should measure and record the length of the shadow and record the direction of the shadow (using drawings and cardinal directions), then use the data to describe the patterns observed.
- The position of the sun in the daytime sky—This daily, cyclical pattern of change can also be directly observed. Students will need the opportunity to make and record observations of the position of the sun in the sky at chosen intervals throughout the day and across a few days. Data should then be analyzed in order to describe the pattern observed.
- The appearance of the moon in the night sky—This cyclical pattern of change repeats approximately every 28 days. Students can use media and online resources to find data that can be displayed graphically (pictures in a calendar, for example), which will allow them to describe the pattern of change that occurs in the appearance of the moon every four weeks.
- The position of the moon in the night sky—This daily, cyclical pattern of change can be directly observed, but students would have to make observations of the position of the moon in the sky at chosen intervals throughout the night, which is not recommended. Instead, students can use media and online resources to learn that the moon, like the sun, appears to rise in the eastern sky and set in the western sky every night.
- The position of the stars in the night sky—Because the position of the stars changes across the seasons, students will need to use media and online resources to learn about this pattern of change.

Whether students gather information and data from direct observations or from media and online sources, they should organize all data in graphical displays so that the data can be used to describe the patterns of change.

Integration of English language arts and mathematics

English language arts

In order to integrate the CCSS for English language arts into this unit, students can use information from print and digital sources to build their understanding of

- The Earth's gravitational force on objects;
- The differences in the apparent brightness of the sun compared to that of other stars due to their relative distances from Earth;
- Patterns of change that occur due to the position and motion of the Earth, sun, moon, and stars.

As students read and gather information from multiple sources, they should integrate and use the information to answer questions and support their thinking during discussions and in their writing.

Mathematics

The CCSS for mathematic are integrated into this unit in a variety of ways. Students reason abstractly and quantitatively when analyzing and using data as evidence to describe phenomena, including:

- The Earth's gravitational force pulls objects "down" (toward the center of the Earth);
- The differences in the apparent brightness of the stars are due to their relative distances from Earth; and
- Patterns of change, such as the day/night cycle, the change in length and direction of shadows during the day, the apparent motion of the sun across the daytime sky and the moon across the nighttime sky, the changes in the appearance of the moon over a period of four weeks, and the seasonal changes in the position of the stars in the night sky.

Students will model with mathematics as they graphically represent data collected from direct observations and from multiple resources throughout the unit, and as they describe relative distances of the sun and other stars from the Earth. Students might also express relative distances between the Earth and stars using numbers that can be expressed using powers of 10.

Future learning

The following disciplinary core ideas are future learning for the concepts in this unit of study.

By the end of middle school, students know that:

- Electrical and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass (e.g., Earth and the sun).
- Forces that act at a distance (electrical, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, a magnet, or a ball, respectively).
- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.
- Earth and its solar system are part of the Milky Way Galaxy, which is one of many galaxies in the universe.

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them.
- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.
- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
- Waters movements—both on land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

Number of Instructional Days

Recommended number of instructional days: 17 (1 day = approximately 45-60 minutes)

Note—The recommended number of days is an estimate based on the information available at this time. Teachers are strongly encouraged to review the entire unit of study carefully and collaboratively to determine whether adjustments to this estimate need to be made.