Sky motions

Novice

- The Sun is at the center of our Solar System.
- The Earth orbits the Sun.
- The Moon orbits the Earth.
- The day is 24 hours long.
- The year is 365 days long.
- Seasons are caused by the tilt of the Earth's axis.
- You can see different stars at night at different times of the year.
- 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.
- 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.
- 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.

Intermediate

- Time of day and sunrise/set are called by the Earth spinning on its axis every 24 hours.
- The Earth orbits the Sun in 365.25 days, and this is why we have leap years.
- The Moon orbits the Earth in
- Seasons are caused by the tilt of the Earth's axis resulting in longer/shorter days, the Sun appearing higher/lower in the sky, and the sunlight hitting each part of the Earth more/less directly. The Earth is actually closest to the Sun in Northern Hemisphere Winter.
- The Sun does not always rise/set due East/West.
- The constellations visible at night are dependent upon the Earth's orbit around the Sun.
- Zodiacal constellations.
- 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.
- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.

Expert
- The analemma
- Explain or design a sunwheel (e.g., Big Horn Medicine Wheel, Stonehenge)
- Ophiuchus, the 13th zodiacal constellation
- Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.

Related NGSS

Grade Level	Student Performance Expectations
3-5	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.**
MS	**MS-ESS1-1** **Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.**
HS	HS-ESS1-4 **Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.**

Related CCSSM

Grade Level	Student Performance Expectations
3-5	**CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.** Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

	CCSS.MATH.PRACTICE.MP4 Model with mathematics. Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose. **CCSS.MATH.CONTENT.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.
MS	**CCSS.MATH.PRACTICE.MP4 Model with mathematics.** Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose. **CCSS.MATH.CONTENT.6.RP.A.1 Ratios and Proportional Relationships** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. **CCSS.MATH.CONTENT.7.RP.A.2 Ratios and Proportional**

		Relationships Recognize and represent proportional relationships between quantities. **CCSS.MATH.CONTENT.6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. **CCSS.MATH.CONTENT.7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.
HS		**CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.** Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects. **CCSS.MATH.PRACTICE.MP4 Model with mathematics.** Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

	CCSS.MATH.CONTENT.HSN.Q.A.1 Quantities Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. **CCSS.MATH.CONTENT.HSN.Q.A.2 Quantities** Define appropriate quantities for the purpose of descriptive modeling. **CCSS.MATH.CONTENT.HSN.Q.A.3 Quantities** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CCSS.MATH.CONTENT.HSA.SSE.A.1** Interpret expressions that represent a quantity in terms of its context. **CCSS.MATH.CONTENT.HSA.CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **CCSS.MATH.CONTENT.HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.