



Science Standard 4
Earth in Space
Grade Level Expectations

Science Standard 4 Earth in Space

Our Solar System is a collection of gravitationally interacting bodies that include Earth and the Moon. Universal principles of gravitation allow predictions regarding the motions of objects within the Galaxy and beyond. Earth's motion, position, and posture account for a variety of cyclic events observable from Earth. While the composition of planets vary considerably, their components and the applicable laws of science are universal. The motions and interactions of objects within the Solar System are consistent with the hypothesis that it emerged from a large disk of gas and dust. Our Solar System is part of the Milky Way Galaxy, which, in turn, is one of many galaxies in the known Universe.

Strand	Grades K-3	Grades 4-5	Grades 6-8	Grades 9-12
<p><u>The Earth/Moon/Sun System</u></p> <p>Enduring Understanding: There are observable, predictable patterns of movement in the Sun, Earth, and Moon system that account for day/night.</p> <p>Enduring Understanding for Grades 6-12: Observable, predictable patterns of movement in the Sun, Earth, Moon system occur because of gravitational interaction and energy from the Sun.</p> <p>Essential Question: Grades K-3: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun?</p> <p>Essential Question: Grades 4-12: What causes these patterns?</p>	<ol style="list-style-type: none"> 1. The shape of the Earth is similar to a sphere. 2. From Earth many objects may be seen in the sky including the Sun, the Moon, stars, and man-made objects. 3. The Sun and Moon appear to move slowly across the sky. 4. The pattern of day and night repeats every 24 hours. The Sun can only be seen in the daytime. 5. The Moon can be observed sometimes at night and sometimes during the day. 6. The appearance of the Moon changes in a cycle that takes about a month. 	<ol style="list-style-type: none"> 1. The apparent path of the Sun, as seen from Earth, is from east to west. Over the course of a day, half of the Earth is always illuminated by the Sun causing day, and the half not illuminated by the Sun experiences nighttime. 2. The cycle from day to night is caused by the Earth's rotation. Earth undergoes one complete rotation about every 24 hours. 3. The Moon orbits the Earth. The appearance of the Moon changes as it moves through its orbit. These changes are called phases. 4. The Sun is much larger than the Moon. Although the Moon is closer to Earth than the Sun, the two appear to be the same size when viewed from Earth. This is because objects appear smaller as the distance from the viewer increases. 	<ol style="list-style-type: none"> 1. The Sun is a star that gives off radiant energy that drives Earth systems and is essential for life. The amount of radiant energy Earth receives from the Sun throughout the year is nearly constant. 2. The tilt of Earth's axis of rotation as it orbits the Sun points in the same direction with respect to the stars. The tilt and the orbital motion of Earth around the Sun cause variation in the amount of solar radiation striking a location on the Earth's surface which results in variation in the length of day/night and seasons. 3. Moon phases occur because the relative positions of Earth, Moon, and Sun change, thereby enabling us to see different amounts of the Moon's surface. 4. The Moon is a natural satellite of Earth and is different than the Earth in size, atmosphere, gravity, and surface features. 5. Tides are caused by the gravitational interactions of the Sun, Moon and Earth. 	<ol style="list-style-type: none"> 1. The source of the Sun's energy is the fusion of hydrogen atoms into helium, a process common in relatively young stars. 2. The Sun's influence on Earth include gravity, (which maintains Earth's orbit), electromagnetic radiation (which provides energy for living things), and energetic particles such as coronal mass ejections that can cause electromagnetic disturbances.

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Strand	Grades K-3	Grades 4-5	Grades 6-8	Grades 9-12
			The Moon has a greater impact on tides because of its proximity to Earth.	
<p><u>The Solar System</u></p> <p>Enduring Understanding: Grades 4-5: Earth is part of a system that includes other planets.</p> <p>Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion (grades 6-8) which are a result of their formation and changes over time (grades 9-11).</p> <p>Essential Question: Grades 4-5: What is Earth's place in the Solar System?</p> <p>Essential Question: Grades 6-8: How does Earth's physical characteristics and motion compare to other bodies in the Solar System?</p> <p>Essential Question: Grades 9-12: How did Earth's crust, atmosphere, and interior form and change over time?</p>		<p>1. Earth is one of the planets in our Solar System that orbits the Sun. The Sun we see during the day is our nearest star. Stars we see at night lie outside our Solar System.</p>	<p>1. The Sun is by far the most massive object in the Solar System, therefore gravitationally dominating all other members of the Solar System.</p> <p>2. The Solar System consists of comets, asteroids, planets, and their respective satellites, most of which orbit the Sun on a plane called the ecliptic. The planets in our Solar System revolve in the same direction around the Sun in elliptical orbits that are very close to being in the same plane. Most planets rotate in the same direction with respect to the Sun.</p> <p>3. Planets can be categorized as inner or outer planets according to density, diameter and surface features.</p> <p>4. Planets and their moons have been shaped over time by common processes such as cratering, volcanism, erosion, and tectonics. The presence of life on a planet can contribute to its unique development.</p>	<p>1. The motion and the basic elements (periodic table) that comprise our Solar System are consistent with the theory that the Solar System emerged from a large disk of gas and dust.</p> <p>2. The Earth's atmosphere, crust, and interior have changed since the formation of the planets. Driven by internal heat (radioactive decay and heat from accretion), the Earth's layers have separated by density into a solid core, molten mantle, and crust of solid rock composed of plates.</p>

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Strand	Grades K-3	Grades 4-5	Grades 6-8	Grades 9-12
<p><u>Stars and Galaxies</u></p> <p>Enduring Understanding: Grades 9-12: The Universe is composed of galaxies that are composed of solar systems, all of which are composed of the same elements and governed by the same laws.</p> <p>Essential Question: Grades 9-12: Is there an order to the Universe? Explain.</p>				<ol style="list-style-type: none"> 1. The Universe consists of billions of galaxies, each of which is a gravitationally bound collection of stars. 2. As a force, gravity causes tides, pulls matter together to make spherical stars and planets, maintains the orbits of planets, and gathers cosmic gas and dust to form stars and star systems. 3. Stars are separated by vast distances. Light which reaches Earth from distant galaxies is millions of years old and is actually a view of the past. 4. The Sun and our Solar System are part of the Milky Way galaxy consisting of billions of other stars that appear to be made of the same elements found on Earth. 5. Most elements are formed as a result of natural astronomical processes, either in the Big Bang itself or in the natural evolution of stars.

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				6. The Big Bang Theory is a core scientific theory that is supported by a large body of evidence and is well accepted by the scientific community. It states that the Universe began in a hot dense state of energy and matter, and the Universe has been expanding ever since.
<p><u>Technology and Applications</u></p> <p>Enduring Understandings: Grades K-5: Technology expands our knowledge of the Earth, Moon, and Sun System. Grades 6-8: Technology expands our knowledge of the Solar System. Grades 9-12: Technology expands our knowledge of the Universe.</p> <p>Essential Questions: Grades K-5: How has technology expanded our knowledge of the Earth, Moon, and Sun System? Grades 6-8: How has technology expanded our knowledge of the Solar System? Grades 9-12: How has technology expanded our knowledge of the Universe?</p>	<p>1. Binoculars allow people to observe objects in the sky from Earth.</p>	<p>1. Humanity’s view of the Solar System has expanded enormously as a result of our exploration of outer space. The Hubble telescope gives us a better view of the many planets than the view we have from the Earth. Robot probes, sent to planets, send back close-up pictures of their surfaces.</p> <p>2. Terrestrial telescopes allow people to observe objects in the sky from Earth.</p>	<p>1. Technology, including humans landing on the Moon, robot landers and other space probes, satellites, and radio telescopes, allow scientists to investigate conditions on Earth and on other objects in the Solar System.</p> <p>2. The technology used in space exploration expands our knowledge of the Universe and has many spin-offs related to everyday applications.</p>	<p>1. Spectroscopes are used to analyze starlight to reveal information about the composition and evolution of stars.</p> <p>2. Technology is vital in investigating the Universe.</p>

Standard 4: Earth in Space, Grade Level Expectations Grades K-3

Essential Question: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun?			
Essential Question: How has technology expanded our knowledge of the Earth, Moon, and Sun System.?			
Enduring Understanding: There are observable, predictable patterns of movement in the Earth, Moon, and Sun system that account for day and night.			
Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.			
All students in Kindergarten will be able to:	Building upon the Kindergarten expectations, all students in Grade 1 will be able to:	Building upon the K-1 expectations, all students in Grade 2 will be able to:	Building upon the K-2 expectations, all students in Grade 3 will be able to:
<p>Enduring Understanding: There are observable, predictable patterns of movement in the Earth, Moon, and Sun system that account for day and night.</p> <p>Describe the shape of the Earth as being like a sphere and describe how a globe models this shape.</p> <p>Name and identify objects that can be observed in the sky including the Sun, Moon, and stars and man-made objects such as airplanes.</p> <p>Describe the repeating cyclic pattern of day and night and include in this description that we can see the Sun only during the daytime.</p> <p>Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.</p> <p>Describe how binoculars help our sense of sight by allowing us to magnify objects in the sky.</p>	<p>Enduring Understanding: There are observable, predictable patterns of movement in the Earth, Moon, and Sun system that account for day and night.</p> <p>List objects that can be observed in the sky in the daytime and objects that can be observed in the sky at nighttime. Discuss which objects are on which lists (e.g., the Moon can be observed sometimes in the day and sometimes at night).</p> <p>Safely observe the location of the Sun at the same time in the morning, noon, and afternoon over several days. Describe the Sun’s movement across the sky over the course of the day.</p> <p>Observe the Moon in the day sky over several months. Draw a sequence of pictures that shows the repeating cyclic pattern of the Moon.</p> <p>Use simple models to demonstrate how Earth’s rotation causes day and night.</p> <p>Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: There are observable, predictable patterns of movement in the Earth, Moon, and Sun system that account for day and night.</p> <p><i>There are no grade level expectations for this understanding.</i></p> <p>Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: There are observable, predictable patterns of movement in the Earth, Moon, and Sun system that account for day and night.</p> <p><i>There are no grade level expectations for this understanding.</i></p> <p>Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.</p> <p><i>There are no grade level expectations for this understanding.</i></p>

Essential Question: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun? What causes these patterns?	
Essential Question: What is Earth's place in the Solar System?	
Essential Question: How has technology expanded our knowledge of the Earth, Moon, and Sun System?	
Enduring Understanding: There are observable, predictable patterns of movement in the Sun, Earth, and Moon system that account for day and night.	
Enduring Understanding: Earth is part of a system that includes other planets.	
Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.	
Building upon the K-3 expectations, all students in Grade 4 will be able to:	Building upon the K-4 expectations, all students in Grade 5 will be able to:
<p>Research and develop a short report on one of the planets in the Solar System. Compare the information learned in the reports.</p> <p>Describe our Sun as a star that is similar to other stars that are seen in the night sky. Explain why our Sun appears to be larger in size than other stars.</p> <p>Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.</p> <p>Use photos gathered from terrestrial telescopes, robot probes, the Hubble telescope, and manned exploration of the Moon to examine pictures of the planets and Moon.</p>	<p>Enduring Understanding: Technology expands our knowledge of the Earth, Moon, and Sun System.</p> <p><i>There are no grade level expectations for this understanding.</i></p>

Standard 4: Earth in Space, Grade Level Expectations Grades 6-8

Essential Questions: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun? What causes these patterns?
Essential Question: How does Earth's physical characteristics and motion compare to other bodies in the Solar System?

Essential Question: How has technology expanded our knowledge of the Solar System?		
Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system are caused by gravitational interaction and powered by energy from the Sun.		
Enduring Understanding: Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion.		
Enduring Understanding: Technology expands our knowledge of the Solar System.		
Building upon the K-5 expectations, all students in Grade 6 will be able to:	Building upon the K-6 expectations, all students in Grade 7 will be able to:	Building upon the K-7 expectations, all students in Grade 8 will be able to:
<p>Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system occur because of gravitational interaction and energy from the Sun.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system occur because of gravitational interaction and energy from the Sun.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system occur because of gravitational interaction and energy from the Sun.</p> <p>Describe how scientists have historically confirmed that the Earth is round, not flat.</p> <p>Analyze data on sunrise and sunset times (in terms of length of daylight) and describe patterns. Explain the reason for the patterns by using models or computer simulations of the Earth and Sun.</p> <p>Using internet, newspaper, and actual observations of the night sky for at least two months, collect data on the Moon's appearance, and moonrise and moonset times. Analyze the data to describe the observable patterns (phases). Explain why the Moon's appearance changes in a repeating cyclical pattern.</p> <p>Use models to describe how the relative positions of the Sun, Moon, and Earth account for Moon phases, eclipses, and tides.</p> <p>Describe how the relative positions of the Earth, Moon and Sun can cause high and low tides, and unusually high or low tides.</p>

Standard 4: Earth in Space, Grade Level Expectations Grades 6-8

Essential Questions: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun? What causes these patterns?
Essential Question: How does Earth's physical characteristics and motion compare to other bodies in the Solar System?

Essential Question: How has technology expanded our knowledge of the Solar System?		
Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system are caused by gravitational interaction and powered by energy from the Sun.		
Enduring Understanding: Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion.		
Enduring Understanding: Technology expands our knowledge of the Solar System.		
Building upon the K-5 expectations, all students in Grade 6 will be able to:	Building upon the K-6 expectations, all students in Grade 7 will be able to:	Building upon the K-7 expectations, all students in Grade 8 will be able to:
<p>Enduring Understanding: All objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: All objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: All objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion.</p> <p>Demonstrate an understanding of the components of our Solar System and their characteristics, including the Moon, the Sun, the planets and their moons, extra-solar planets, and smaller objects such as asteroids and comets. Construct scale models of the Solar System in order to describe the relative sizes of planets and their distances from the Sun.</p> <p>Use a variety of resources (e.g., NASA photographs, computer simulations) to compare and contrast the physical properties (i.e., temperature, size, composition, surface features) of planets.</p> <p>Demonstrate an understanding of the motion of the bodies in our Solar System. Use models, charts, illustrations, and other suitable representations to predict and describe regular patterns of motion for most objects in the Solar System.</p> <p>Explain how the Sun is the central and largest body in our Solar System and the source of the light energy that hits our planet. Use models to explain how variations in the amount of Sun's energy hitting the Earth's surface results in seasons.</p> <p>Recognize that the force of gravity keeps planets in orbit around the sun and influences objects on Earth and other planets (i.e., tides, ability of humans to move and function). Differentiate between an object's mass and weight.</p>

Standard 4: Earth in Space, Grade Level Expectations Grades 6-8

Essential Questions: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun? What causes these patterns?
Essential Question: How does Earth's physical characteristics and motion compare to other bodies in the Solar System?

Essential Question: How has technology expanded our knowledge of the Solar System?		
Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system are caused by gravitational interaction and powered by energy from the Sun.		
Enduring Understanding: Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion.		
Enduring Understanding: Technology expands our knowledge of the Solar System.		
Building upon the K-5 expectations, all students in Grade 6 will be able to:	Building upon the K-6 expectations, all students in Grade 7 will be able to:	Building upon the K-7 expectations, all students in Grade 8 will be able to:
<p>Enduring Understanding: Technology expands our knowledge of the Solar System.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: Technology expands our knowledge of the Solar System.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: Technology expands our knowledge of the Solar System.</p> <p>Describe how scientists have acquired knowledge about components of our Solar System. Recognize the importance of people and technologies that have led to our current understanding of space.</p> <p>Recognize that spin-offs are products which have undergone a technology transfer process from research to public use. Research and report on spin-offs from the space program that have affected our everyday lives (i.e., Velcro, smoke detectors, cordless tools).</p>

Standard 4: Earth in Space, Grade Level Expectations Grades 9-12

Essential Questions: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun? What causes these patterns?
Essential Question: How does the Sun influence a planet's physical characteristics and motion?

Essential Question: Is there an order to the Universe? Explain.	
Essential Question: How has technology expanded our knowledge of the Universe?	
Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system are caused by gravitational interaction and powered by energy from the Sun.	
Enduring Understanding: Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion which are a result of their formation and changes over time.	
Enduring Understanding: The Universe is composed of galaxies that are composed of solar systems, all of which are composed of the same elements and governed by the same laws.	
Enduring Understanding: Technology expands our knowledge of the Universe.	
Building upon the K-8 expectations, all students in Grade 9 will be able to:	Building upon the K-11 expectations, all students in Grade 12 will be able to:
<p>Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system are caused by gravitational interaction and powered by energy from the Sun.</p> <p><i>There are no grade level expectations for this understanding.</i></p> <p>Enduring Understanding: Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion which are a result of their formation and changes over time.</p> <p>Explain the formation of solar systems using the Solar Nebular Theory including the origin of the planets and Sun from the nebula, the evolution of planets, and the dispersal of left over gas and dust.</p> <p>Describe how the Earth formed (using the Solar Nebular Theory) into a solid core, molten mantle, crust of solid rock composed of plates, and early atmosphere as a result of the densities of the elements.</p>	<p>Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system are caused by gravitational interaction and powered by energy from the Sun.</p> <p>Describe how nuclear fusion reactions change over time and lead to the creation of elements (and the evolution of stars).</p> <p>Explain how the process of nuclear fusion in our Sun consumes mass and releases, over billions of years, enormous amounts of energy.</p> <p>Compare and contrast the age, temperature, and size of our Sun to other stars.</p> <p>Discuss the many ways in which the Sun influences Earth including the role of gravity, coronal mass ejections, and electromagnetic radiation including gamma photons.</p> <p>Enduring Understanding: Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion which are a result of their formation and changes over time.</p> <p>Use library and internet resources to identify characteristics of the Earth which permit it to support life, and compare those characteristics to properties of other planets. Based on the research, debate the possibility of life on other planets.</p>

Standard 4: Earth in Space, Grade Level Expectations Grades 9-12

Essential Questions: What predictable, observable patterns occur as a result of the interaction between the Earth, Moon, and Sun? What causes these patterns?
Essential Question: How does the Sun influence a planet's physical characteristics and motion?
Essential Question: Is there an order to the Universe? Explain.

Essential Question: How has technology expanded our knowledge of the Universe?	
Enduring Understanding: Observable, predictable patterns of movement in the Sun, Earth, Moon system are caused by gravitational interaction and powered by energy from the Sun.	
Enduring Understanding: Most objects in the Solar System orbit the Sun and have distinctive physical characteristics and orderly motion which are a result of their formation and changes over time.	
Enduring Understanding: The Universe is composed of galaxies that are composed of solar systems, all of which are composed of the same elements and governed by the same laws.	
Enduring Understanding: Technology expands our knowledge of the Universe.	
Building upon the K-8 expectations, all students in Grade 9 will be able to:	Building upon the K-11 expectations, all students in Grade 12 will be able to:
<p>Enduring Understanding: The Universe is composed of galaxies, which are composed of solar systems, all of which are composed of the same elements and governed by the same laws.</p> <p><i>There are no grade level expectations for this understanding.</i></p> <p>Enduring Understanding: Technology expands our knowledge of the Universe.</p> <p><i>There are no grade level expectations for this understanding.</i></p>	<p>Enduring Understanding: The Universe is composed of galaxies, which are composed of solar systems, all of which are composed of the same elements and governed by the same laws.</p> <p>Describe the relative size differences and distances between planetary systems, stars, multiple-star galaxies, star clusters, galaxies, and galactic groups in the Universe.</p> <p>Explain why the force of gravity is responsible for many phenomena in the Universe including the formation and life cycle of galaxies, stars, and planetary systems. Explain how gravity influences the motion of bodies in the Universe including tides and maintaining orbits of planets.</p> <p>Describe how our knowledge of the history of the Universe is based on electromagnetic energy that has traveled vast distances and takes a long period of time to reach us.</p> <p>Explain the life history of stars in terms of luminosity, size and temperature using the Hertzsprung-Russell Diagram. Compare and contrast stellar evolution based on mass (black hole, neutron star, white dwarf).</p> <p>Explain the Big Bang Theory and how it is supported by evidence that includes microwave background radiation and red shift. Cite research supporting the Big Bang Theory as the most scientifically accepted theory explaining the formation of the Universe.</p> <p>Enduring Understanding: Technology expands our knowledge of the Universe.</p> <p>Describe how the composition of stars can be determined by analysis of their spectra. Compare the elements that compose stars to those that compose Earth.</p> <p>Discuss how technology (i.e., telescopes, computers, space probes, radio observatories) assists astronomers in discovering and investigating celestial bodies beyond the limits of our Solar System.</p>