

ESS1.A: The Universe and Its Stars

Grade/Course	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
1	<ul style="list-style-type: none"> Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1)
5	<ul style="list-style-type: none"> 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)
8	<ul style="list-style-type: none"> Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (8-ESS1-1) Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (8-ESS1-2)
<p>Earth and Space Science</p>	<ul style="list-style-type: none"> Nuclear fusion within stars releases electromagnetic energy (seen as starlight). Stars go through a sequence of developmental stages over their lifespans--they are formed; evolve in size, mass, and brightness; and eventually burn out. The Sun is a medium sized star that is about halfway through its predicted life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. (E-ESS1-1) The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (E-ESS1-2) Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Stars’ radiation of visible light and other forms of energy can be measured and studied to develop explanations about the formation, age, and composition of the universe. The study of stars’ light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (E-ESS1-2) The study of stars’ light spectra and brightness is used to identify compositional elements of stars. Stars go through a sequence of developmental stages--they are formed; evolve in size, mass, and brightness; and eventually burn out. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. Material from earlier stars that explode as supernovas is recycled to form younger stars and their planetary systems. (E-ESS1-3)

ESS1.B: Earth and the Solar System

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1	<ul style="list-style-type: none"> Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)
5	<ul style="list-style-type: none"> 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)
8	<ul style="list-style-type: none"> This model of the solar system can explain tides (including spring and neap), 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. (8-ESS1-1) The solar system consists of the sun, planets, their moons, and other celestial objects that are held in orbit around the sun by its gravitational pull on them. (8-ESS1-2) The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (8-ESS1-2) The solar system consists of the sun, planets, their moons, and other celestial objects that are held in orbit around the sun by its gravitational pull on them. (8-ESS1-3)
<p>Earth and Space Science</p>	<ul style="list-style-type: none"> 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. (E-ESS1-4) The Solar System consists of the Sun and a collection of objects of varying sizes and conditions. This system appears to have formed from a disk of dust and gas, drawn together by gravity approximately 4.6 billion years ago. (E-ESS1-6) Cyclical changes in the shape of Earth’s orbit around the sun, together with changes in the orientation of the planet’s axis of rotation, both occurring over tens to hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause cycles of ice ages and other gradual climate changes. (secondary) (E-ESS2-4)

ESS1.C: The History of the Planet Earth

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2	<ul style="list-style-type: none"> Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)
4	<ul style="list-style-type: none"> Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)
6	<ul style="list-style-type: none"> The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. Major historical events include the formation of mountain chains and ocean basins, the adaptation and extinction of particular living organisms, volcanic eruptions, periods of massive glaciation, and development of watersheds and rivers through glaciation and water erosion. (6-ESS1-4)
Earth and Space Science	<ul style="list-style-type: none"> Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches. (E-ESS1-5) Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the Solar System, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history. Study of other planets and their moons, many of which exhibit features such as volcanism and meteor impacts similar to those found on Earth, also help illuminate aspects of Earth’s history and changes. (E-ESS1-6)

Adapted from *The Framework for K-12 Science Education* and the *Next Generation Science Standards*.

References:

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States (Appendix E: Disciplinary Core Idea Progression)*. Retrieved from <https://www.nextgenscience.org/>