Fairfield Public Schools
Science Curriculum

Science of the Cosmos

Science of the Cosmos: Description

This course will focus on the theories and principles of Astronomy, and on the science and practices that are used to understand our observations of the universe. Emphasis will be placed on current theories and recent developments in space exploration. Questions about the stars, planets, and universe will be answered through discussion, investigation, and laboratory activities designed to give students a firsthand knowledge of, and appreciation for, the universe in which they live.

Standards for this course are taken from the *Next Generation Science Standards* and are of three types:

Disciplinary Core Ideas (DCIs): Shown as content objectives, these standards define what students should know about the most essential ideas in the major science disciplines. The focus is on a limited number of core ideas in science and engineering both within and across the disciplines to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.

Science and Engineering Practices (SEP): These standards enable students to apply the content in the DCI's and the skills of practicing scientists and engineers to explain phenomena and solve real world problems. Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.

Crosscutting Concepts: These standards provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. These broad concepts tie together the influence of engineering, technology, and science on society and the natural world.

http://www.nextgenscience.org/next-generation-science-standards

Science of the Cosmos

Enduring Understandings

- Energy in a system determines the lifetime of a star, and contributes to the Law of Conservation of Energy through the star's ability to perform nuclear fusion and effect on planets within its solar system.
- There is a relationship between light, temperature, composition, age, and distance of a star as observed from Earth.
- Observations that support the Big Bang Theory and our expanding universe.
- Patterns of motion are governed by laws determined by Galileo, Newton, and Kepler.
- Minimal change in celestial objects provide information about the solar system's age and history

Course Essential Questions

- Why do we study the night sky?
- Over history, how has the cosmos been explained?
- How is the solar system organized?
- How do distances govern the structure of the universe?
- What is at the edge of our understanding of astronomy?
- How do students use information and technology to express and communicate ideas?

Science of the Cosmos: Year-at-a Glance

Unit	Title	Unit Essential Questions
1	Earth's Place in the Universe	• How can we model the orbits of objects? • What evidence helps us date crustal rocks?
2	History and Tools of Astronomy	• Why is the nuclear fusion in the sun important to life on Earth? • What scientific evidence do we have about the beginning of our universe? • Why is spectroscopy a significant tool in astronomical observations?
3	Our Planetary System and Motion Laws	• How can we model the movement of things in orbit? • What evidence do scientists have to deduce the age of the Earth and its early history? • Why is there life on Earth and what scientific evidence can we use to explain it?
4	Stars and Stellar Evolution	• What are the structure and properties of the Sun? • How do a star's properties affect its life cycle? • How is the creation of chemical elements related to stars and their life cycle? • How does the Hertzsprung-Russell diagram compare stars?

Unit 1: Earth's Place in the Universe

Overview

The Earth's place in space is elucidated as the view in the sky is studied. During the day, the Sun's apparent motion is studied. At night, the constellations are identified and the Earth's and the Moon's orbital motions are described. For finding long distances, students learn triangulation and parallax techniques.

Performance Expectations

At the conclusion of this unit, students will be able to:

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history

Unit Essential Questions

- How can we model the orbits of objects?
- What evidence helps us date crustal rocks?

Crosscutting Concepts

Patterns

- Empirical evidence is needed to identify patterns. (HS-ESS1-5)

Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

ESS1.B: Earth and the Solar System

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. (HS-ESS1-4)

ESS1.C: The History of Planet Earth

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. (HS-ESS1-5)

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. (HS-ESS1-6)

ESS2.B: Plate Tectonics and Large-Scale System Interactions

Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (secondary to HS-ESS1-5)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Using Mathematical and Computational Thinking

- Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)

Constructing Explanations and Designing Solutions

- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)

Engaging in Argument from Evidence

- Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)

Corresponding CT Core Standards:

ELA/Literacy – SL 8.5

Mathematics – MP.4, 6.RP, A.1., 7.RP, A.2

Unit 2: History and Tools of Astronomy

Overview

The history of astronomy involves studying the geocentric theories understood for thousands of years as well as the more modern heliocentric theory. The invention of the telescope led to proof of the heliocentric theory. Then, the technological advances in telescopes has led to spectroscopy. Students will learn about types of telescopes and forms of incoming electromagnetic radiation we detect.

Performance Expectations

At the conclusion of this unit, students will be able to:

HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.

HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

Unit Essential Questions

- Why is the nuclear fusion in the sun important to life on Earth?
- What scientific evidence do we have about the beginning of our universe?
- Why is spectroscopy a significant tool in astronomical observations?

Crosscutting Concepts

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)

Energy and Matter

- Energy cannot be created or destroyed– only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

ESS1.A: The Universe and Its Stars

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)
- 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. (HSESS1-2)
- 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. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1)

Constructing Explanations and Designing Solutions

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS1-2)

Corresponding CT Core Standards:

ELA/Literacy –RST.11-12.1, WHST .9-12.2

Mathematics – MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3, HSA-SSE.A.1, HSA-CED.A.2, HSA-CED.A.4

Unit 3: Our Planetary System and Motion Laws

Overview

Students will research and describe the planets of the solar system, both terrestrial and Jovian. To understand planetary motion, the laws of Newton and Kepler will be studied.

Performance Expectations

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Unit Essential Questions

- How can we model the movement of things in orbit?
- What evidence do scientists have to deduce the age of the Earth and its early history?
- Why is there life on Earth and what scientific evidence can we use to explain it?

Crosscutting Concepts

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-EES1-6) (HS-ESS2-7)

Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

ESS1.B: Earth and the Solar System

- 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. (HS-ESS1-4)

ESS1.C: The History of Planet Earth

- 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. (HS-ESS1-6)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Using Mathematical and Computational Thinking

- Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)

Constructing Explanations and Designing Solutions

- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)

Engaging in Argument from Evidence

- Construct an oral and written argument or counterarguments based on data and evidence. (HS-ESS2-7)

Corresponding CT Core Standards:

ELA/Literacy – RST.11-12.1, RST.11-12.8, WHST.9-12.1, WHST.9-12.2

Mathematic – MP2, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3, HSA-CED.A.2,HSS-ID.B.6

Unit 4: Stars and Stellar Evolution

Overview

Students will learn about star formation, evolution, and death. Studying star properties will allow stars, including the Sun, to be classified and compared. It will be shown that the Hertzsprung-Russell diagram compares many star properties at once.

Performance Expectations

At the conclusion of this unit, students will be able to:

HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Unit Essential Questions

- What are the structure and properties of the Sun?
- How do a star's properties affect its life cycle?
- How is the creation of chemical elements related to stars and their life cycle?
- How does the Hertzsprung-Russell diagram compare stars?

Crosscutting Concepts

Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HSESS1-3)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

ESS1.A: The Universe and Its Stars

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)
- 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. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3)

SCIENCE AND ENGINEERING PRACTICES (SEP):
Obtaining, Evaluating, and Communicating Information

- Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS1-3)

Corresponding CT Core Standards:

ELA/Literacy – WHST.9-12.2

Mathematics – MP.2