Astronomy Unit 3 - How Far?

Content Area: **Science**
Course(s): **Astronomy**
Time Period: **Full Year**
Length: **18 days**
Status: **Published**

NJSLS - Science

SCI.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.
SCI.HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
SCI.HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
SCI.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.

Science and Engineering Practices

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) Using

Mathematical and Computational Thinking

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

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)

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)

Disciplinary Core Ideas

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)

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)

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)

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)

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) In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3)

Rationale and Transfer Goals

Use of mathematical and computational thinking enables us to examine the processes governing the workings of the solar system and universe. Scale, proportion, and quantity are organizing concepts. We can gain perspective of the universe by understanding the scale of distances and units of measure. The notion of physical laws and processes are universal. Astronomy makes use of other well-established sciences like physics and chemistry.

Enduring Understandings

Distances used for astronomical purposes must cover larger scales: astronomical units, light years, parsecs.

The significance of a phenomenon is dependent on the scale, proportion and quantity at which it occurs.

Patterns may depend on one's point of view.

Space travel is generally not regarded as the best for space exploration.

Much of science deals with constructing explanations of how things change and how they remain stable.

Nine planets of very different sizes, composition, and surface features move around the Sun in nearly circular orbits.

The Sun, Moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described. Objects in the sky have patterns of movement. The Sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. Most objects in the

Solar System are in regular and predictable motion.

The patterns of stars stay the same although they appear to move across the sky nightly, and different stars can be seen during different seasons. Planets change their positions against the background of stars.

Astronomy is based on observations and experiments that can be repeated, and that give the same results no matter who does the experiment or makes the observation.

Astronomy makes precise predictions about our Universe that can be tested to see if the predictions are true or not.

Essential Questions

Where are the bodies in our galaxy located?

Is there a pattern to where the bodies in our solar system are located?

How far are astronomical bodies from Earth? Why is it impractical to use distance units we use on Earth for distance units we use in astronomy?

Why is it currently impractical for humans to travel to other bodies in the universe?

Why do stars in one constellation appear to be the same distance from each other relative to Earth?

When you look at the night sky, does it seem like the universe is mostly full of “stuff”, or does it seem mostly empty?

Content - What will students know?

- Definitions of AU, LY, ps
- Stars that make up a constellation are not near each other.
- Basics: Kepler's Laws to relate orbital speeds, periods, and distances of the planets.

Skills - What will students be able to do?

- Measure distances proportionally on adding machine tape and on the football field.
- Convert distance units.
- How to measure with angular size, angular distance, and parallax.
- Use astronomical distances to make a constellation model.
- Explain Johannes Kepler's 3 laws of the motion of the planets.
- Explain the standard magnitude scale.
- Explain that absolute brightness and luminosity are an intrinsic measure of a star.
- Define apparent magnitude, absolute magnitude and luminosity.
- Relate apparent to absolute magnitude.

Activities - How will we teach the content and skills?

- Paper solar system (ASTRO)
- Constellation on a box or with yarn (TOPS)
- Parallax (including video with instructions, since this is a difficult activity to envision and set up)
- Powerpoint

Evidence/Assessments - How will we know what students have learned?

- Analysis questions after making and using models
- Quizzes

- Tests
- Astronomy Benchmark #1

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Metric units for distance • Unit conversions • Mathematical and computational skill from previous grade levels (cross multiply/ratios/proportions) • Use mathematical representations to describe and/or support claims and/or explanations	• Distance measurements • Unit conversions • Moon cycle	• Review metric units for distance • Review moon phases (basics - cyclical in nature, repeats approximately every 28 days)

Key Resources

TOPS Learning Systems

Project Astro https://www.astrosociety.org/education/hands-on-astronomy-activities/

https://www.astro.princeton.edu/~dns/teachersguide/website.pdf

http://stem-works.com/external/activity/627

21st Century Life and Careers

WRK.9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
WRK.9.2.12.CAP.4	Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.
WRK.9.2.12.CAP.5	Assess and modify a personal plan to support current interests and post-secondary plans.
WRK.9.2.12.CAP.6	Identify transferable skills in career choices and design alternative career plans based on those skills.

Career Readiness, Life Literacies, & Key Skills

TECH.9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
TECH.9.4.12.IML.6	Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5).
TECH.9.4.12.IML.7	Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).

Interdisciplinary Connections/Companion Standards

NJSLS Mathematics

MP.2 Reason abstractly and quantitatively. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-4)

MP.4 Model with mathematics. (HS-ESS1-1), (HS-ESS1-4)

HSN-Q.A.1 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. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)

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. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4) .

NJSLS ELA

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS1-1), (HS-ESS1-2)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2), (HS-ESS1-3)

SL.11-12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. (HS-ESS1-3)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS1-1), (MS-ESS1-2)

Companion Standards for ELA in Science and Technical Subjects: Reading

<u>Key Ideas and Details</u>

RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

Companion Standards for ELA in Science and Technical Subjects: Writing

Text Types and Purposes

WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.