Course: Astronomy **Unit #4:** The Universe	**Year of Implementation:** 2025-2026

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Stage One - Desired Results

Link(s) to New Jersey Student Learning Standards for this course:
https://www.nj.gov/education/standards/

Unit Standards:

- ***Content Standards***
  - **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 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.
  - **HS-ESS1-3.** Communicate scientific ideas about the way stars, over their life cycle, produce elements
  - **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-PS4-3**. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
  - **HS-PS4-4** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
  - **HS-PS4-5**. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
  - **HS-PS2-1**. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

- **HS-PS2-4**. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
- **HS-LS2-4** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
  - ***Science and Engineering Practices***

The content of this unit will strengthen student skills in the following SEPs.

- Practice 1 Ask Questions
- Practice 2 Developing and Using Models
- Practice 3 Planning and Carrying Out Investigations
- Practice 4 Analyzing and Interpreting Data
- Practice 5 Using Mathematics and Computational Thinking
- Practice 6 Constructing Explanations and Designing Solutions
- Practice 7 Engaging in Argument from Evidence
- Practice 8 Obtain, Evaluate and Communicate Information

- ***21st Century Life & Career Standards***
  - 9.4.12.CI.1 - Demonstrate the ability to reflect, analyze and use creative skills and ideas
  - 9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
  - 9.4.12.IML.3 - Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
  - 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).
  - 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
  - 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
  - All curriculum writers/revisionists need to include standards that apply to "Career Readiness, Life Literacies, and Key Skills". This should include a brief description of the standard and the standard number. Document only those standards and practices that apply to each unit. Use the following link to assist you [see pages of 31-36; 41-42; 53-56 for specific standard #'s and strands]

https://www.state.nj.us/education/cccs/2020/2020%20NJSLS-CLKS.pdf

- ***English Companion Standards***
  - NJSLSA.R1. Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
  - NJSLSA.R2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
  - NJSLSA.R4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
  - NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
  - NJSLSA.R8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
  - NJSLSA.R10. Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed.
  - NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
  - NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
  - NJSLSA.W3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
  - NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
  - NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
  - NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
  - NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.

        - NJSLSA.W8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
        - NJSLSA.W9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
        - NJSLSA.W10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

        - List grade-level appropriate companion standards for History, Social Studies, Science and Technical Subjects (CTE/Arts) 9-12. English Companion Standards are required only in these subject/content areas. This section can be deleted for all other content areas.
        - Grade 9-10 Companion Standards: https://www.nj.gov/education/standards/ela/Docs/2016NJSLS-ELA_Companion9-10.pdf
        - Grade 11-12 Companion Standards: https://www.nj.gov/education/standards/ela/Docs/2016NJSLS-ELA_Companion11-12.pdf
    - ***Interdisciplinary Content Standards***
        - MP.2 - Reason abstractly and quantitatively.
        - MP.4 - Model with mathematics.
        - 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.
        - HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.
        - HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
        - HSA-SSE.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
        - 6.2.12.HistoryCC.2.b: Explore the factors that laid the foundation for the Renaissance (i.e., Asian and Islamic, Ancient Greek and Roman innovations).
        - List any standards from other content areas that apply to this unit.

    - ***NJ Statutes:*** NJ State law mandates the inclusion of the following topics in lesson design and instruction as aligned to elementary and secondary curriculum.

Amistad Law: N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Holocaust Law: N.J.S.A. 18A:35-28 Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35 A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36) A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.

Diversity and Inclusion (N.J.S.A. 18A:35-4.36a) A board of education shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards.

Asian American and Pacific Islanders (AAPI) P.L.2021, c.410 Ensures that the contributions, history, and heritage of Asian Americans and Pacific Islanders (AAPI) are included in the New Jersey Student Learning Standards (NJSLS) for Social Studies in kindergarten through Grade 12 (P.L.2021, c.416)

For additional information, see

NJ Amistad Curriculum: ***https://www.nj.gov/education/amistad/about/***

Diversity and Inclusion: ***https://www.nj.gov/education/standards/dei/index.shtml***

- *(Sample Activities/ Lessons):* ***https://www.nj.gov/education/standards/dei/samples/index.shtml***

Asian American and Pacific Islanders:

- ***Asian American and Pacific Islander Heritage and History in the U.S.***
  A Teacher's Guide from EDSITEment offering a collection of lessons and resources for K-12 social studies, literature and arts classrooms that center around the experiences, achievements and perspectives of Asian Americans and Pacific Islanders across U.S. history.

Transfer Goal: Students will be able to independently use their learning to make predictions to solve problems or answer questions, based on a limited amount of information.

As aligned with LRHSD Long Term Learning Goal(s): https://www.lrhsd.org/academics/program-of-studies/curriculum

The Lenape Regional High School District Science program, in alignment with the New Jersey Core Curriculum Content Science Standards, prepares our students to become scientifically literate and informed citizens able to function in an increasingly complex society. Through completing our coursework with its emphasis on authentic experiences that enable students to investigate and explain scientific phenomena, our students will be better able to

1. design, critique, and carry out experiments in order to investigate scientific questions and/or propose solutions
2. collect, interpret, and analyze data in order to solve a defined problem
3. apply mathematics to express relationships efficiently and accurately
4. draw evidence-based conclusions from data in order to make informed decisions;
5. construct, interpret, and refine models (scientific and mathematical) to explain the physical and natural world
6. effectively communicate scientific ideas and evidence-based arguments to an appropriate audience through written and oral means
7. evaluate the validity of arguments that rely on scientific reasoning presented in the popular press and informational sources

Enduring Understandings	*Essential Questions*
Students will understand that. . . *EU 1* observations and theories have shaped our understanding of the universe	• How can we describe and understand the universe's nature, structure, and origins?

EU 2 it is probable that life exists elsewhere in the universe.	● How does the search for life beyond Earth challenge and deepen our understanding of life on Earth?
<u>Knowledge</u> *Students will know . . .* *EU 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 gasses, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. **(HS-ESS1-2, HS-ESS1-4, HS-ESS1-1)** ● galaxies; their classifications and characteristics **(HS-PS4-3, HS-PS4-4, HS-PS4-5, HS-ESS1-1, HS-ESS1-3)** ● the contributions made by Einstein and Hubble to explaining the universe **(HS-PS4-3, HS-PS4-4, HS-PS4-5, HS-ESS1-2, HS-ESS1-4)** ● 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, HS-PS2-4)** ● more distant objects are moving away faster, and their differences can be determined by measuring their redshifts. **(HS- PS2-4, HS- PS2-5)** ● recent observations show the expansion of the universe is accelerating, indicating that dark matter and dark energy play a role in the process. **(HS- PS2-4, HS-PS2-5, HS-ESS1-2)**	*<u>Skills</u>* *Students will be able to. . .* *EU 1* ● classify galaxy types according to the Hubble "Tuning Fork" model. **(HS-ESS1-2)(SEP2)** ● identify and describe distances and major features of the Milky Way Galaxy **(HS-PS2-4)(SEP4)** ● evaluate evidence of a "Big Bang". **(HS-ESS1-2) (SEP7, SEP8)(9.4.12.IML.3)** ● predict an observer's observations in the behavior of light and time given multiple scenarios. **(HS-PS4-3 HS-PS4-4 HS-PS4-5, 9.4.12.IML.2)(SEP4, SEP6)** ● compare Einstein's general relativity perspective to Newton's concept of gravity. **(HS-PS4-1, HS-PS4-4, HS-PS2-1, HS-PS2- 4)(SEP8)(9.4.12.IML.4)** ● analyze the concept of redshift and describe how it indicates the universe is expanding **(HS-ESS1-2, HS-PS2-1) (SEP7, SEP8)(9.4.12.IML.3)** ● describe how a three dimensional object would appear to a two dimensional observer if it passes through its universe. **(HS-PS2-1, HS-PS4-5, HS-ESS1-2) (SEP5, SEP6)(9.4.12.CI.1)**

EU 2 ● based on probability, it is unlikely life exists on Earth alone. **(HS-ESS-1-1, HS-ESS1-2, HS-ESS1-6, HS-PS4-4)** ● the Drake Equation was developed to calculate the probability of intelligent/communicative life on other planets. **(HS-ESS-1-1, HS-ESS1-2, HS-ESS1-6, HS-PS4-4)** ● spontaneous generation states life formed from chemical building blocks in Earth's primordial atmosphere. **(HS-LS2-4, HS-ESS-1-1, HS-ESS1-2, HS-ESS1-6, HS-PS4-4)** ● extraterrestrial origin states that life formed from organic molecules which were introduced via comets or meteors. **(HS-ESS1-6, HS-ESS1-3)** ● it is thought Mars and Europa are locations where life could exist within the solar system. **(HS-ESS1-6, HS-ESS1-3)** ● it is believed that life on other worlds would need favorable conditions to support life, such as the availability of water. **(HS-ESS1-6, HS-ESS1-3)** ● space-based telescopes have identified thousands of exoplanets, many of which may have the potential to support life. **(HS-ESS1-6, HS-ESS1-3)**	*EU 2* ● 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) (SEP2, SEP6, SEP7, SEP8)(9.4.12.IML.4)** ● identify regions around a star which may be supportive to life. **(HS- ESS1-1, HS-ESS1-6, HS-ESS1-3)(SEP2, SEP4, SEP5, SEP7, SEP8)** ● 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) (SEP2, SEP4, SEP5, SEP7, SEP8)(9.4.12.CI.1)** ● given estimates of the variables in the Drake equation, calculate the number of intelligent civilizations near Earth. **(HS-ESS1-1, HS-ESS1-6, HS-ESS1-3)(SEP2, SEP4, SEP5, SEP7, SEP8)(9.4.12.CI.1)** ● match current scientific research goals with the Drake equation variable the goal seeks to address. **(HS-ESS1-6, HS-ESS1-3)(SEP2, SEP4, SEP5, SEP7, SEP8)(9.4.12.TL.1)** ● identify variables of the Drake equation which have the greatest impact on the equation's outcome. **(HS-ESS1-6, HS-ESS1-3)(SEP2, SEP4, SEP5, SEP7, SEP8)(9.4.12.IML.2)**

Stage Two - Assessment

Performance Task:

Other Evidence:

- Quizzes
- Summarizers
- Essays
- Research
- Presentations
- Formal lab write ups
- Discussions
- Diagrams
- Models
- Debate
- CER
- Unit Test

Stage Three - Instruction

Learning Plan: **Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.** *{place A, M and/or T along with the applicable EU number in parentheses after each statement} All knowledge and skills must be addressed in this section with a corresponding lesson/activity which teaches each concept. The following color codes are used to notate activities that correspond with interdisciplinary connections and 21st Century Life & Career Connections (which involves Technology Literacy): Red = Interdisciplinary Connection; Purple = 21st Century Life & Career Connection*

PHENOMENON: There is an unimaginable amount of galaxies in the universe. **(A/M/T) (EU1,EU2)**
https://science.nasa.gov/image-article/most-colorful-view-of-universe-captured-by-hubble-space-telescope/
Hubble vs James Webb
Goal: Students will be able to make predictions, or answer questions based on limited information, demonstrating how observations and theories have shaped our understanding of the universe.**(A/M/T) (EU1,EU2)**

1. Teacher-led discussion and notes on the structure of the Milky Way and other galaxies. **(A/M) (EU1)**
   To include :
   - galaxies are congregations of billions of stars.
   - the universe contains billions of galaxies.
   - galaxies can be classified as having relatively predictable forms and characteristics.
   - the earth is located in the Perseus arm of a barred spiral galaxy called the Milky Way.
   - many galaxy types are favorable locations for star formation.
   - many galaxies (including the Milky Way) are organized around supermassive black holes.
   - the solution to Olbers paradox shows the universe is finite in both age and size.
   - the universe began approximately 13.8 billion years ago in a high energy expansion from a single point called the "Big Bang".
   - the forms and complexity of matter and energy have changed significantly since the Big Bang.
2. Starry Night Activities http://www.starrynighteducation.com/products-astronomy-education-high-school.html **(A/M/T) (EU1)**
   H- Galaxies and the Universe
   H1: The Milky Way Galaxy
3. Students construct three dimensional models of the Milky Way galaxy. **(M) (EU1)**
4. Calculate the number of stars in the observable universe **(M) (EU1)**
5. Teacher-led discussion and notes on the Hubble classification system To include:. **(A) (EU1)**
   - Edwin Hubble concluded the universe is expanding equally from all points at a constant rate.
   - more distant objects are moving away faster, and their differences can be determined by measuring their redshifts.
6. Students will engage in a galaxy sorting activity. **(A) (EU1)**
7. Starry Night Activities http://www.starrynighteducation.com/products-astronomy-education-high-school.html **(A/M/T) (EU1, EU2)**

- H2: The Universe
- H3: The Origin and Evolution of the Universe

8. Teacher-led discussion and notes on Einstein's special and general relativities. To include: **(A) (EU1)**
   - Einstein's theory of special relativity is related to the special behaviors of light.
   - Einstein's theory of general relativity describes the relationship between mass and gravity by developing the concept of spacetime.
   - spacetime directs the behavior of matter, and matter warps the shape of spacetime.
9. Doppler effect demonstration using sound. **(A/M/T) (EU1)**
10. Use of a spandex "Gravity Table" to demonstrate the relationship between spacetime and mass. **(A/M) (EU1)**
11. Students will evaluate evidence supporting the Big Bang theory and the age of the universe.**(M) (EU1)**
12. Students will make predictions in an observer's observations in the behavior of light and time given multiple scenarios. (**A/M) (EU1)**
13. Calculation activities to determine the velocity and distance of a galaxy moving away from Earth by analyzing its redshift.**(M) (EU1)**
14. Calculation activity where students derive the Hubble constant given galaxy velocities or redshift data. **(M) (EU1)**
15. Teacher-led discussion and notes on exobiology. **(A, EU2)**
16. Given values for the Drake equation variables, calculate the probability of nearby intelligent civilizations. **(A/M) (EU2)**
17. Research, evaluate, and report information on known or suspected "goldilocks" star systems. **(A/M) (EU2)**
18. Videos: Interstellar, Universe series, Cosmos series, Crash Course Astronomy series, Alien Planet, Europa Report, The Arrival **(A/M/T) (EU1, EU2)**

- Videos: To be used at the teachers discretion (can be **A,M,T** depending on use)
  - The Universe http://www.history.com/shows/the-universe
  - Crash Course Astronomy https://www.youtube.com/playlist?list=PL8dPuuaLjXtPAJr1ysd5yGIyiSFuh0mIL
  - Through the Wormhole Series https://www.sciencechannel.com/tv-shows/through-the-wormhole/
  - How the Universe Works https://www.sciencechannel.com/tv-shows/how-the-universe-works/
  - The Cosmos Series http://channel.nationalgeographic.com/cosmos-a-spacetime-odyssey/ **(A/M)**

Other useful links for **PHENOMENON:**
https://thewonderofscience.com/phenomenon/2018/7/8/the-big-bang-theory -The Big Bang Theory
Building Blocks of Life Found on Samples Collected From an Asteroid

Pacing Guide

{This chart will be identical in all of the units for this course.}

Unit #	***Title of Unit***	***Approximate # of teaching days***
1	Our Place in Space	40
2	The Solar System	30
3	The Stars	40
4	The Universe	25

Instructional Materials

- Starry Night High School - web/chromebook version
- Fully equipped science lab
- Spandex for demo
- Markers
- Crayons
- Colored Pencils
- Rulers
- Poster Paper
- Graph Paper
- Anchor Paper
- Plain Paper
- Scissors

- Variety of spectrum tubes
- Spectrum Tube Power Supply
- Calculators
- Posters of galaxies

Accommodations

Special Education: The curriculum will be modified as per the Individualized Education Plan (IEP). Students will be accommodated based on specific accommodations listed in the IEP.
Students with 504 Plans: Students will be accommodated based on specific accommodations listed in the 504 Plan.
English Language Learners: Students will be accommodated based on individual need and in consultation with the ELL teacher.
Students at Risk of School Failure: Students will be accommodated based on individual need and provided various structural supports through their school.
Gifted and Talented Students: Students will be challenged to enhance their knowledge and skills through acceleration and additional independent research on the subject matter.