Astronomy Unit 5 - How Old?

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

NJSLS - Science

HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
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.
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.

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)

Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)

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)

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. (HS-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. 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)

PS4.A: Wave Properties

The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)

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. (HSESS1-3)

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)

Rationale and Transfer Goals

Explanations based on valid and reliable evidence can be obtained from a variety of sources.

We assume 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.

Science is a process, showing the evolution of scientific ideas.

Astronomy provides people with the opportunity to make observations, test hypotheses, make models, analyze evidence and hypotheses, and think critically (including appropriate skepticism).

Enduring Understandings

The origin of the universe remains one of the greatest questions in science.

The Big Bang theory describes the origin of the universe and is supported by observations of moving celestial objects, including galaxies and stars.

The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state; according to this theory, the universe has been expanding ever since.

The current theory is that its entire contents expanded explosively from a hot, dense, chaotic mass. Eventually, some stars exploded, producing clouds of heavy elements from which other stars and planets could later condense in a process that is ongoing.

Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars.

The electromagnetic spectrum describes the various forms of radiation that exist in our universe, and each form of radiation can be differentiated based on wavelength, frequency and speed.

Each different wavelength of electromagnetic radiation has a unique signature, and is based on the composition of the object emitting that radiation.

Spectroscopy is the branch of science that measures spectra produced when matter emits electromagnetic radiation. Different elements, stars, galaxies, as well as other objects in space have spectra that allow us to identify their composition.

Using known spectral signatures, the Doppler effect shows how the movement of an object towards or away from the viewpoint can shift the spectra of an object. This shift allows scientists to know what direction an object in space is moving.

The Sun is many thousands of times closer to Earth than any other star. Light from the Sun takes only a few minutes to reach Earth, but light

from the next nearest star takes a few years to arrive. Some distant galaxies are so far away that their light

takes several billion years to reach

Earth. People on Earth, therefore, see the stars as they were that long ago in the past.

Because the light seen from almost all distant galaxies has longer wavelengths than comparable light on Earth, astronomers believe the whole universe is expanding.

Essential Questions

How does the size and composition of a star influence the path it takes during its lifetime?

How does nuclear fusion inside a star work and how does the presence or absence of fuel move a star from one phase of its life into the next?

How can various characteristics of a star be measured by astronomers?

Does the H-R diagram provide scientists with valid information about the category, temperature or brightness of a star?

Can the movement of distant objects in space be observed from Earth with validity?

Can information about light spectra, motion of galaxies, and composition of matter in the universe support the Big Bang theory?

How can the Big Bang theory explain the origins and expansion of our universe?

Content - What will students know?

- The size and composition of a star influence the path that it takes during its lifetime.

- The observed wavelength of a wave depends upon the relative motion of the source and the observer (Doppler effect: red shift v. blue shift).
- Because the light seen from almost all distant galaxies has longer wavelengths than comparable light on Earth, astronomers believe that the whole universe is expanding.
- The structure and composition of a star are used to define and categorize it.
- Different types of stars follow similar, yet different, life cycle patterns.
- The life cycle of a star is primarily based on the size of the protostar.
- Stars all begin from dust, and the formation of a star will follow a series of events.
- Nuclear reactions within stars create the radiation emitted and are fueled by hydrogen and/or helium, depending on the life stage of the star.
- The Hertzsprung-Russell diagram is a useful tool for analyzing data on star temperature, brightness and color and is used to classify stars.
- Main sequence stars can be categorized into 7 different spectral classes (O, B, A, F, G, K, and M) based on common properties, including temperature, color, mass, luminosity, and life span.

Skills - What will students be able to do?

- Compare and contrast stellar evolution for low- and high-mass stars.
- Explain the life track of a star using an H-R diagram.
- Describe the life cycle of a star and explain the role gravity and mass play in the brightness, life span, and end-stages of stars.
- Relate nuclear fusion reactions and mass-energy equivalence to the life cycle of stars.
- Determine a star's intrinsic properties of luminosity, temperature, radius and composition and with this plot it on a Hertzsprung Russell (H-R) diagram.
- Explain the evolutionary path of the Sun on the HR diagram.
- Explain the challenges faced by astronomers due to the properties of light and the vast distances in the cosmos.

Activities - How will we teach the content and skills?

- Life Cycle of Stars (Astro)

- Visualizing the Expansion of Space (Astro)
- Light Spectra(Relate light's properties (wavelength, frequency, speed, energy) with each other.
- Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
- Discuss how spectroscopy provides information about the inherent properties and motions of objects.
- How stars create elements: nuclear fusion (video - drawings)
- Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.
- Fusion is the joining of two nuclei at extremely high temperature and pressure, and is the process responsible for the energy of the sun and other stars.
- The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state; according to this theory, the universe has been expanding ever since. Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars.

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

- **Assessments can be reviewed for each course in this folder.**
- Analysis questions after making and using models
- Quizzes
- Tests
- Astronomy Benchmark #2

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
Waves Unit - Grade 8		

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://earthguide.ucsd.edu/virtualmuseum/images/briefhistuniverse.html

http://astronomy.nmsu.edu/nicole/teaching/dste110/syllabus.shtml

21st Century Life and Careers

9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
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.
9.2.12.CAP.5	Assess and modify a personal plan to support current interests and post-secondary plans.
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

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).
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).
9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
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.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).
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).
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).
9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Interdisciplinary Connections/Companion Standards

