Integrated Science Unit 2: The Energy of Space

Content Area: **Science**
Course(s): **Integrated Science**
Time Period: **MP2**
Length: **45 days**
Status: **Published**

NJSLS - Science

SCI.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
SCI.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
SCI.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.
SCI.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.
SCI.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.
SCI.HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
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-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
SCI.HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

Science and Engineering Practices

Asking Questions and Defining Problems

- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2)

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)

Engaging in Argument from Evidence

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3)

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)

- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)

- Communicate technical information or 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-PS4-5)

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8)

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5)

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-2), (HS-PS4-3)

Disciplinary Core Ideas

LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS- LS1-5)

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)

- 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)

PS1.C: Nuclear Processes

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)

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)
- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2), (HS-PS4-5)
- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS- PS4-3)

PS4.B: Electromagnetic Radiation

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4- 3)
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)
- Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS- PS4-5)

PS4.C: Information Technologies and Instrumentation

- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)

Crosscutting Concepts

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)

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), (HS-PS1-8)
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5)

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2), (HS-ESS1-4)

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-ESS1-2)
- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-ESS1-2)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS- PS4-1)
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4)
- Systems can be designed to cause a desired effect. (HS-PS4-5)

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS- PS4-3)

Stability and Change

- Systems can be designed for greater or lesser stability. (HS- PS4-2)

Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems. (HS- PS4-2), (HS-PS4-5)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2)

Rationale and Transfer Goals

In the previous unit, students learned about the energy of motion in everyday occurrences on Earth. In this unit, students will be introduced to energy that exists outside of their world and in the universe itself. Major concepts in this unit include the reviewing evidence that supports the theory of the Big Bang, star formation, the life cycle of stars, and how elements found here on earth were formed in the heart of stars long ago. Students will be able to utilize real world uses of electromagnetic radiation found on Earth to help cement big ideas of how we know so much about the universe given our limited traveling capacity in space.

Enduring Understandings

- Research that looks at the movement of bodies in space shows that the universe began with the event known as The Big Bang
- The orbit of stars and planets can be predicted by mathematical computation
- Fueled by nuclear reactions occurring in the atoms of it's core, stars release large amount of many different types of energy
- Electromagnetic radiation travels as wave-like particles and can be described using the variables of frequency, wavelength, and its speed of travel.
- Electromagnetic radiation is used in everyday devices found around the world.

Essential Questions

- How do we know anything about stars if we've never been to one? (phenomenon)
- Why does the sun have so much energy?(phenomenon)
- Where did all the energy in the universe come from?(phenomenon)

- What is the Big Bang and what does it mean for use today?(phenomenon)
- How can light be useful, other than just making the world a brighter place?(phenomenon)
- How can I call someone on the other side of the planet with just my cell phone?(phenomenon)
- If radio waves and gamma rays are both types of electromagnetic radiation, why is one safe and the other so dangerous?(phenomenon)

Content - What will students know?

- The composition of stars can be determined through the analysis of emission spectra found in the light given off of stars.
- Nuclear reactions deep inside of a star are the source of a star's energy.
- The theory of the Big Band states that the universe as we know it started from a highly dense point called the singularity before all the matter in the universe was released outwards after a large explosion of the stellar material inside.
- Electromagnetic radiation has many uses in today's world.
- The differences among types of EM radiation stems from variations in theEnergy, wavelength and frequency of the waves, while the speed remains constant throughout the types.

Skills - What will students be able to do?

- Analyze emission spectra to determine the makeup of stars, comparing the results to the known spectra of elements on earth.
- Identify sources of energy in stars and provide an explanation for how energy can be derived from stars.
- Using evidence of the movement of stars and other astral bodies, students will be able to defend the theory of the Big Bang, citing proof from the evidence to support the claim.
- Identify how many modern devices work and rely on electromagnetic radiation.
- Explain the differences found between types of electromagnetic radiation using wavelength, frequency, and energy.

Activities - How will we teach the content and skills?

- Students will complete thislab activity which looks at the composition of stars through emission spectra.
- Students will complete a literacy activity on the following article on how stars derive energy from the nuclear reactions within them.
- Students will complete this shortlab activity to help explain the expansion of the universe.
- Students will complete this virtual lab which goes into the uses and differences of the types of EM radiation.
- Students will complete a literacy activity, focusing on the essential question asking to determine the differences among waves.

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

- **Assessments can be reviewed for each course inthis folder.**
- Students will complete thislab activity which looks at the composition of stars through emission spectra. They will complete select questions to check for their understanding.
- Students will be asked to provide a brief and general explanation of how stars produce and give off energy.
- Students will be asked to defend the theory of the Big Bang in a literacy activity, citing evidence given in an article for their explanation.
- Students will complete the question set provided on this virtual lab activity.
- Students will complete this assessment to check for their understanding.
- Integrated Science Unit 2 Benchmark

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Electromagnetic radiation can be used in many different ways in everyday devices. • The Big Bang theory states the universe started as a	• Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. • Use mathematical	• Students will complete an energy flow diagram of how cell phones work (focusing on the transfer of energy from one form to another).

point of singularity containing the very dense mass of the entire universe. • The Big Bang caused all of the mass in the universe to accelerate outwardly from the point of singularity.	representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. • 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.	• Students will compare the motion of stars and galaxies in the universe and provide evidence for the Big Bang. • Students will use Newton's laws to help explain the motion of stars and galaxies in an effort to support the theory of the big bang.

Key Resources

Glencoe Physical Science

Phet Simulations

Google Classroom

Brain Pop

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.

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.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
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.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).
TECH.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.
TECH.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).
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).

Interdisciplinary Connections/Companion Standards

Science Standard	Math Connection	ELA Connection	Science N
Patterns in rates of change and other numerical relationships can provide information about natural and human-designed systems.	Recognize and represent proportional relationships between quantities.	Close Reading of Text: Read closely to determine what the text says explicitly and make logical inferences.	MS-PS1-
Graphs, charts, and images can be used to identify patterns in data.	Describe qualitatively the functional relationship between two quantities by analyzing a graph.	Diverse Media and Formats: Synthesize content presented in diverse media and formats, including visually and quantitatively, as well as in words.	MS-E
Planning and Carrying out Investigations: Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually.	Make sense of problems and persevere in solving them.	Participate Effectively: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners.	SI