BPS Science Department Earth Science - Unit 5 - Space

Unit 5 - During this unit, students will 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. Students will 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. They will also communicate scientific ideas about the way stars, over their life cycle, produce elements. Students will use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate

Driving Questions:

- How do scientists study objects in space that are at vast distances from Earth?
- What types of evidence enable scientists to make inferences about the sizes, temperatures, and distances of stars?
- How are scientific inquiry and engineering design interrelated in the field of astronomy? How might new instruments and tools help astronomers expand their knowledge of the universe?
- How do astronomers interpret lines of evidence to support a theory that explains the formation and history of the universe?

NYSSLS Standards:

Lesson 5.1: In this lesson, students construct explanations (SEP Constructing Explanations and Designing Solutions) of the methods of investigating space, identifying electromagnetic radiation as the main source of data (DCI.HS-ESS1.A The Universe and Its Stars). Students explore how waves change (CCC Energy and Matter) as the objects producing them approach and recede from an observer (DCI.HS-ESS1.A The Universe and Its Stars). Students evaluate spectra (DCI.HS-ESS1.A The Universe and Its Stars, DCI.HS-PS4.B Electromagnetic Radiation) and use these characteristics to determine the presence of certain elements.

- **HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.**
  - **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)
- **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.**
  - **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)
  - **PS4.B Electromagnetic Radiation**
    - Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)

Lesson 5.2: In this lesson, students apply evidence to construct an explanation (SEP Constructing Explanation and Designing Solutions) of properties among stars (DCI.HS-ESS1.A The Universe and Its Stars). Students investigate and illustrate the role of nuclear fusion in the sun's core to release energy (CCC Energy and Matter) that eventually reaches Earth in the form of radiation (DCI.HS-ESS1.A The Universe and Its Stars, DCI PS3.D Energy in Chemical Processes and Everyday Life). Students analyze a graph of sunspot frequency to describe variations in solar activity (DCI ESS2.A Earth Materials and Systems) related to changes in electromagnetic radiation (DCI ESS2.D Weather and Climate) over decadal time scales (CCC Scale, Proportion, and Quantity). Finally, students investigate star evolution (DCI ESS2.A Earth Materials and Systems) and explain how stars, over their life cycle, produce elements.

- **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 form of radiation.**
  - **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. (HSESS1-1)
  - **PS3.D Energy in Chemical Processes and Everyday Life**
    - Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to HS-ESS1-1)
- **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.**
  - **ESS1.A The Universe and Its Stars**

        - 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)
- **HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.**
    - **ESS1.A The Universe and Its Stars**
        - 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)
- **HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.**
    - **ESS2.A Earth Materials and Systems**
        - The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)
    - **ESS2.D Weather and Climate**
        - The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-4),(secondary to HS-ESS2-2)

Lesson 5.3: In this lesson, students construct explanations (SEP Constructing Explanations and Designing Solutions) based on evidence from patterns found in light spectra and the motion of galaxies (DCI ESS1.A The Universe and Its Stars). Students also use graphs and data displays (SEP Developing and Using Models) to understand and interpret the distance and movement of bodies and systems in the universe (DCI ESS1.A The Universe and Its Stars, CCC Scale, Proportion, and Quantity). Students apply these scientific principles to interpret patterns in size and distance as orders of magnitude and to draw conclusions about the composition, size, and distance of objects in the universe.

- **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.**
    - **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)
- **HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.**
    - **ESS1.A The Universe and Its Stars**
        - 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)

Lesson 5.4: In this lesson, students construct and revise explanations of the big bang theory (SEP Constructing Explanations and Designing Solutions) based on multiple lines of evidence (DCI ESS1.A The Universe and Its Stars). In particular, students investigate the apparent motion of galaxies, the detection of cosmic background radiation, and the measured ratio of light elements (DCI ESS1.A The Universe and Its Stars) (CCC Energy and Matter).

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

BPS Science Department Earth Science - Unit 5 - Space

Science & Engineering Practices (link to SEP break-down):	**Crosscutting Concepts (link to guiding questions for CCC):**
• Constructing Explanations and Designing Solutions • Developing and Using Models • Obtaining, Evaluating, and Communicating Information • Planning and Carrying Out Investigations	• Stability and Change • Cause and Effect • Energy and Matter • Patterns • Scale, Proportion, and Quantity

Opportunities for Student Collaboration p. 231J (Complete Collaboration Strategy Guide):
● **Accessing Prior Knowledge** pp. 232, 233 ● **Group Discussion** pp. 237, 238, 241, 244, 245, 249, 252, 261, 275, 281, 284 ● **Think, Pair, Share** pp. 258, 270, 285, 295 ● **Group Activity** pp. 240, 271, 287, 290 ● ● **Claims, Evidence, and Reasoning** pp. 255, 267 ● **Speed Teach** p. 259 ● **Modeling** p. 263 ● **Systems & Methods for Detecting Exoplanets** p.279 ●

Time Frame	Lesson Framework	Instructional Sequence	Resources- HMH Dimensions- Earth & Space Science Textbook	Resources- HMH Dimensions Digital Component	Additional Resources
12/5/22-12/23/22	**Unit 5: Space**		• **Unit Opener (Pre-Assessment): Predict-**What tools and techniques do you think scientists use to study galaxies and other objects across the vast distances of space? (pp. 230-231)	• **Unit Project: Citizen Science-** Students select appropriate citizen science projects on which to collaborate with space science professionals. As part of the project, they obtain and evaluate information regarding aspects regarding light spectra in space, motion of distant galaxies, composition of matter in the universe, stars and their life cycles, the flow of electromagnetic energy in space, or other key concepts discussed in the unit. They plan and participate in relevant investigations, communicate information about their experiences, and construct explanations about what they learned.	
	Lesson 5.1 Observing Matter in Space In this lesson, you will explain how methods and tools use electromagnetic spectra to observe matter and events in space. **Vocabulary**: electromagnetic spectrum • frequency • Doppler effect • spectrum • parallax	**Engage**	• **Phenomenon: Can You Explain It?-** How do scientists gather information about objects in space that are too far to visit? (p. 232)		**ESRT:** • Electromagnetic Spectrum (p. 14) **You Solve It Simulation- How Can We Determine How Rapidly Galaxies Are Moving?** Students will determine the relationship between the velocity at which a galaxy moves in relation to the observer and the galaxy's distance, magnitude, or diameter.
		Explore/ Explain	• **Exploration 1-** Types of Observations (pp. 233-236) • **Exploration 2-** The Doppler Effect (pp. 237-239) • **Exploration 3-** Spectra (pp. 240-243) • **Exploration 4-** Studying Objects (pp. 244-247)	• **Lesson 1- Observing Matter in Space PPT (editable)** • **Exploration 4: Hands-On Lab- Modeling Parallax-** In this lab, students use objects around them to model and observe parallax. • **Exploration 4: Hands-On Lab- Blackbody Radiation-** In this lab, students view the colors and brightnesses produced by incandescent light bulb filaments as they vary the temperature.	
		Elaborate	• **Continue Your Exploration-** Data Analysis: Spectral Analysis (p. 248)	• **Continue Your Exploration:** ○ Spectroscopist	

				○ **Exploration 3:** **Hands-On Lab- Make and Use a Spectroscope-** In this lab, students make a simple spectroscope and use it to observe various light sources. ○ The Electromagnetic Spectrum	What happens to light waves when they travel from their source to an observer? Doppler Effect and RedShift Simulator
		Evaluate	• **Lesson Self Check** (pp. 249-251)- Can You Explain It- Revisit • **Make Your Own Study Guide** (p. 251) • **Checkpoint Questions** (pp. 250-251)	• **Can You Explain It?** Revisit • **Checkpoint Questions** • **Make Your Own Study Guide** • **Unit 5- Lesson 1 Quiz**	
	Lesson 5.2 Stars In this lesson, you will model nuclear fusion in the sun's core, explain different properties among stars, and explain variations in solar activity and their impact on Earth. **Vocabulary**: nuclear fusion magnetic field sunspot interstellar medium	**Engage**	• **Phenomenon: Can You Explain It?-** Why do distant stars appear to have different colors? (p. 252)		**ESRT:** • Characteristics of Stars (p. 15)
		Explore/ Explain	• **Exploration 1-** Energy and the Sun (pp. 253-256) • **Exploration 2-** Properties of Stars (pp. 257-259) • **Exploration 3-** Star-Forming Regions (pp. 260-262) • **Exploration 4-** Matter Transformations in Stars (pp. 263- 265)	• **Lesson 2- Stars PPT (editable)** • **Exploration 1:** **Hands-On Lab- Modeling Fusion-** In this lab, students use coins to model the process of nuclear fusion.	
		Elaborate	• **Continue Your Exploration-** **Hands On Lab- Thermal Spectra** (p. 266) In this lab, students use household objects to investigate the relationships among energy, color, and temperature.	• **Continue Your Exploration:** ○ Star Evolution ○ Comparing Stars ○ Star Classification	
		Evaluate	• **Lesson Self Check** (pp. 267-269)- Can You Explain It- Revisit • **Make Your Own Study Guide** (p. 269) • **Checkpoint Questions** (pp. 268-269)	• **Can You Explain It?** Revisit • **Checkpoint Questions** • **Make Your Own Study Guide** • **Unit 5- Lesson 2 Quiz**	
	Lesson 5.3 The Universe In this lesson, you will develop models to show orders of magnitude in the solar system and in the wider universe and explain scientific principles and patterns that govern the composition, size, distance, and motion of objects in the universe. **Vocabulary**: light-year	**Engage**	• **Phenomenon: Can You Explain It?-** How should we define the edge of our solar system? What factors need to be considered? (p. 270)		
		Explore/ Explain	• **Exploration 1-** The Scale of the Universe (pp. 271-276) • **Exploration 2-** Patterns in the Universe (pp. 277-279)	• **Lesson 3- The Universe PPT (editable)** • **Exploration 1:** **Hands-On Lab- It's a Long Way to Neptune-** In this lab, students convert and apply data to create a model of the solar system and relative orbital positions of the planets, and create an accurate scale representation of the solar system.	

		Elaborate	• **Continue Your Exploration- Guided Research:** Mapping the Milky Way (p. 280)	• **Continue Your Exploration:** ○ Exploring the Universe ○ Design Your Own Scale Model ○ On the Universe Scale	
		Evaluate	• **Lesson Self Check** (pp. 281-283)- Can You Explain It- Revisit • **Make Your Own Study Guide** (p. 283) • **Checkpoint Questions** (pp. 282-283)	• **Can You Explain It?** Revisit • **Checkpoint Questions** • **Make Your Own Study Guide** • **Unit 5- Lesson 3 Quiz**	
	Lesson 5.4 Evidence for the Big Bang In this lesson, you will explain the big bang theory based on three lines of evidence and develop and use models to show how the theory and its evidence are consistent with existing understanding of nuclear processes in stars. **Vocabulary**: big bang theory plasma cosmic microwave background (CMB)	**Engage**	• **Phenomenon: Can You Explain It?-** How is it possible for us to know about events that happened in the universe billions of years ago? (p. 284)		
		Explore/ Explain	• **Exploration 1-** What is the Big Bang Theory? (pp. 285-286) • **Exploration 2-** Evidence of the Expanding Universe (pp. 287-289) • **Exploration 3-** Evidence from the Early Universe (pp. 290-293)	• **Lesson 4- Evidence for the Big Bang PPT (editable)** • **Exploration 2: Hands-On Lab- Modeling the Expanding Universe-** In this lab, students model the expansion of the universe in two different ways.	
		Elaborate	• **Continue Your Exploration- Guided Research:** Contributors to the Big Bang Theory (p. 294)	• **Continue Your Exploration:** ○ Summarizing Evidence ○ Science Writer	
		Evaluate	• **Lesson Self Check** (pp. 295-297)- Can You Explain It- Revisit • **Make Your Own Study Guide** (p. 297) • **Checkpoint Questions** (pp. 296-297)	• **Can You Explain It?** Revisit • **Checkpoint Questions** • **Make Your Own Study Guide** • **Unit 5- Lesson 4 Quiz**	
	Thing Explainer		• **Our Star** (pp. 298-301)		
	Enrichment: Unit Connection Activities (Optional)		• **Engineering-** Designing Space Telescopes • ***Social Studies-** Light Pollution • **Technology-** Space Weather		
	Unit Close		• **Synthesize the Unit** (p. 303) • **Driving Questions** (revisit) • **Practice and Review Questions** (pp. 303-304) • **Unit Project** Revisited (p.304) • **Unit Performance Task** (p. 305)	• **Assessment Guide**: ○ Unit Test A- provides an in-depth assessment of the Performance Expectations aligned to the unit. ○ Unit Test B can be used to assess students who need extra support	Castle Learning HMH Earth & Space Science Unit 5- Space (Editable item bank available under Public Assignments in Castle Learning)

BPS Science Department Earth Science - Unit 5 - Space

Resources

http://ngss.nsta.org/Classroom-Resources.aspx - Searchable NYSSLS/NGSS aligned resources curated by NSTA
BPS Earth Science Website– BPS Earth Science curriculum resource hub
BPS Science Department Recommended Virtual Labs – Virtual lab resources with embedded links to virtual labs and student sheets. Must be logged into BPS google account through BPS Gmail account to access.
BPS Science Department CER Student Writing Template (BPS Science Department CER Practice with a Graph)
NYSED's Office of State Assessment webpage - Access to Released Regents Earth Science Examinations
Science Learning Standards (HS) – NYSSLS High School Standards for Earth Science
NYSED Bilingual Glossaries – NYS Statewide Language Regional Bilingual Education Resource for NYSED approved bilingual glossaries.

English Language Learners (ELL) Enhancements To access hyperlinked material, you must be logged into your BPS Google Drive	**Listening** • **Cross- Linguistic Practices:** Gives students opportunities to make connections between what they hear and their home language (For example, allow students to listen to a passage and identify cognates.) • **Build background knowledge** • **Activating Prior Knowledge** • **Activating prior knowledge** means both eliciting from students what they already know and building initial knowledge that they need in order to access upcoming content • **Visuals** - GIFs, pictures- will assist students in understanding what they are listening to. **Visual thinking strategies** set the lens for learning. • Video to review/ introduce a topic – use **closed captioning** so students see the words and pronunciations while they listen to the content. • **Word stretching / Vowel stretching** allows student to listen closely to the pronunciation words • **Performance Level Descriptors** - this document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of listening Scroll for grades 9-12.	**Speaking** • **Sentence Frames** - to begin a sentence - such as *Evolution is…* or *I think that evolution is…* • **Academic Conversation Starters:** Have a visual of a list of academic sentence starters that students can refer to in a discussion such as *I expect __ to happen.* or *My data shows that…* This aids students in having more science focused dialogue. • **Choral Reading** - Build fluency, self-confidence and motivation with reading/speaking • Create **movement** to go with the word. Movement can be a motivating factor and kinesthetic tool for conceptualizing the rhythm and flow of fluent reading while triggering brain function for optimal learning • **Performance Level Descriptors** - this document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of speaking. Scroll for grades 9-12	**Reading** • **Supplementary Text** to reinforce concepts. If necessary, use lower Lexile levels to ensure comprehension. • **Visual Aids** - Pictures or models to support vocabulary words/ concepts • Video to review introduce a topic - use **closed captioning** so students can read along and listen to content • **4 Square / Frayer models** to help students gain a deeper understanding of vocabulary. • **Highlighting** important text to assist students in answering questions after the reading. • **Chunking**-Break reading of text into chunks or paragraphs • **Vocabulary Morphology**- segmenting words into affixes (prefixes/suffixes) and roots/base words. Understanding that words connected by meaning/origin can be connected by spelling can be critical to expanding a student's vocabulary. • **Performance Level Descriptors**- this document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of reading. Scroll for grades 9-12.	**Writing** • **Sentence Frames** - to begin a sentence- such as *Biodiversity is…* or *An example of competition is….* • **Cloze passages** with word banks • **Word banks** • **Graphic Organizers** to help break down the writing process and organize thoughts • **Standards-based sentence stems** • **Performance Level Descriptors**- this document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of writing. Scroll for grades 9-12.	**Instructional Accommodations (depending on the student's needs)** • **Extended time** for tests in class, projects and assignments • **Directions read.** Broken down as necessary • **Model** how to complete the activity in the lesson • **Oral simplification** of directions or questions • **Translated version** of test when available. Student may have both version English and native language version • Use of **approved bilingual glossaries** from NYS in each subject

BPS Science Department Earth Science - Unit 5 - Space

<table>
<tr>
<td>Special Education Modifications

Special Education students must have accommodations as per Individual Educational Plan (IEP)</td>
<td><u>Instructional</u>
● Pre-teach vocabulary
● Use picture vocabulary
● Scaffold Depth of Knowledge questions
● Provide copy of notes/notes in “cloze” form
● Use of Think, Pair, and Share strategy to help process information
● Scaffold written assignments with the use of graphic organizers
● Allow for multiple ways to respond (verbal, written, response board)
● Provide model of performance task
● Modify informational text to fit the needs of the students
● Provide a digital or paper interactive notebook
● Present complex tasks in multiple ways
Provide mnemonic strategies for Living Environment concepts</td>
<td><u>Technology:</u>
● Audio reading of text
● Text to type functions
● Videos to clarify/visualize Living Environment concepts
● Record class lecture/discussions and make accessible to student
● Nearpod- interactive presentations of notes
● Playposit - show a video clip about the topic and add your own questions for them to answer as they watch
● Allow students to type answers in chat on Teams

<u>Other:</u>
● Arrange seating for maximum engagement and minimum distraction
● Accessible lab space (counter level)</td>
<td><u>In Class Assessments</u>

● Provide review packet or review sheet of concepts covered on the test
● Practice similar questions prior to the test
● Provide multiple options for projects
● Give a timeline of when things are due and remind them of the process often.
● Use of timer in class
● Break all complex tasks into chunks</td>
</tr>
<tr>
<td>BPS Science K-12 Schoology Folder:
9-12 Resources
Earth Science Resources
Curriculum Materials</td>
<td colspan="3"><u>SUTW Strategies</u>
● Informal Outline
● Color-Coding – Informative/Explanatory Text
● Two-column notes
● I-V-F Topic Sentence progressing to Four Step Summary Paragraph
● CUPS – Capitalization, Usage, Punctuation, Spelling
● Transitions</td>
</tr>
<tr>
<td>Culturally and Linguistically Responsive Teaching (CLRT) in the Science Classroom</td>
<td colspan="3">Materials, resources, and/or discussions address diverse cultural backgrounds and real-world applications
● Artifacts (posters, charts, etc.) in the science classroom are representative of the cultures of the student population
● All students are given an opportunity to engage in science discourse
● Teacher demonstrates high expectations for all students

CLRT resources which align to Science content are denoted with a *</td>
</tr>
</table>