BPS Science Department Earth Science - Unit 4 - Earth in the Solar System

Unit 4 - During this unit, students will use mathematical or computational representations to predict the motion of orbiting objects in the solar system. Students will 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. Students will also analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. 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 has gravity influenced the formation and motion of Earth over time?
- How can we use our understanding of physical laws and the behavior of objects to understand Earth's formation and history in the solar system?
- What factors affect climate on Earth?
- How can you use evidence from Earth's surface to understand how climate has changed through time?

NYSSLS Standards:

Lesson 4.1: In this lesson, students learn how engineering, technology, and science have helped society gain knowledge and develop models about the formation, structure, and composition of the solar system (CCC Influence of Engineering, Technology, Science on Society and the Natural World). They analyze observations that led to different models of the solar system and interpret physical data related to the formation of objects in the solar system (SEP Analyzing and Interpreting Data). Students also explore how the structure and composition of the solar system and planets have changed over time (CCC Stability and Change) and use evidence to engage in arguments regarding planetary proximity to the sun and planetary composition (SEP Engaging in Argument from Evidence). Further, students examine how studies of Earth's materials give insight into Earth's formation and early history (DCI ESS1.C The History of Planet Earth).

- **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.**
  - **ESS1.C The History of Planet Earth**
    - Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6)
- **HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.**
  HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to Earth's systems.
  - **ESS2.A Earth Materials and Systems**
    - Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS- ESS2-1), (HS-ESS2-2)

Lesson 4.2: In this lesson, students analyze and interpret information (SEP Analyzing and Interpreting Data) about orbital patterns in the solar system (CCC Patterns) to better understand Kepler's laws and Newton's law of gravitation (DCI ESS1.B Earth and the Solar System). Students use algebraic thinking (CCC Scale, Proportion, and Quantity) to predict how changes in one orbital parameter impact others (CCC Stability and Change). Students also use scientific evidence to engage in arguments (SEP Engaging in Argument from Evidence) regarding how orbital changes can be used to deal with space junk and other problems.

- **HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.**
  - **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)
- **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.**
  - **ESS1.B Earth and the Solar System**
    - Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

Lesson 4.3: In this lesson, students analyze and interpret data (SEP Analyzing and Interpreting Data) regarding the effects of Earth's interaction with the sun on Earth systems (DCI.ESS2.A Earth Materials and Systems, DCI.ESS2.D Weather and Climate). Students use Earth-sun system models (SEP Developing and Using Models) to examine changes in the radiant energy reaching Earth's surface (DCI.ESS1.B Earth and the Solar System) and to understand causal factors (CCC Cause and Effect) of changes in Earth systems over time (CCC Stability and Change).

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- **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.**
  - **ESS1.B Earth and the Solar System**
    - Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)
  - **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 to intermediate 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)

Science & Engineering Practices (link to SEP break-down):
- Analyzing and Interpreting Data
- Developing and Using Models
- Planning and Carrying Out Investigations
- Engaging in Argument from Evidence
- Using Mathematical and Computational Thinking

Crosscutting Concepts (link to guiding questions for CCC):
- Stability and Change
- Cause and Effect
- Patterns
- Scale, Proportion, and Quantity
- Influence of Engineering, Technology and Science on Society and the Natural World

Opportunities for Student Collaboration p. 175H (Complete Collaboration Strategy Guide):
● **Self-Assessment** p. 212 ● **Think, Pair, Share** pp. 179, 184, 187, 213, 215 ● **Which is False?** p. 183 ● **Discussion** pp. 189, 203 ● **Four Corners** pp. 196, 198, 208 ● ● **Showdown** p. 197 ● **Numbered Heads Together** p. 217 ●

Time Frame	Lesson Framework	Instructional Sequence	Resources- HMH Dimensions- Earth & Space Science Textbook	Resources- HMH Dimensions Digital Component	Additional Resources
11/14/22-12/2/22	**Unit 4: Earth in the Solar System**		• **Unit Opener (Pre-Assessment): Predict-** What factors might scientists consider in distinguishing planets from smaller objects in the solar system such as dwarf planets? (pp. 174-175)	• **Unit Project: Model Another Solar System** - Using their understanding of our own solar system, students model another planetary system consisting of at least one star of a mass different from our sun's, three planets, and one object with a highly eccentric orbit. Student deliverables can be a drawing, physical, or computer model and should demonstrate an understanding of both object size and orbital scale.	
	Lesson 4.1 Solar System Formation In this lesson, you will explain the formation, early history, and structure and composition of Earth and the solar system.	**Engage**	• **Phenomenon: Can You Explain It?-** What can be learned from impact craters on the moon and on Earth? (p. 176)		**ESRT:** • Solar System Data (p. 15) • Radioactive Decay Data (p. 1) Why Do Seasons Occur on Earth? Pre-Assessment Probe
		Explore/ Explain	• **Exploration 1-** The Solar System (pp. 177-179) • **Exploration 2-** Solar System Formation (pp. 180-184) • **Exploration 3-** Evidence of Earth's History (pp. 185-187) ○ Design an Impact Crater Investigation	• **Lesson 1- Solar System Formation PPT (editable)** • **Exploration 3: Hands-On Lab- Simulation of Nuclear Decay-** In this lab, students simulate nuclear decay, generate and analyze data, and compare the results of two simulation procedures.	

	Vocabulary: volatile solar wind protoplanetary disc nebula	**Elaborate**	• **Continue Your Exploration- Guided Research:** Taurus Molecular Cloud (p. 188)	• **Continue Your Exploration:** ○ The Oort Cloud ○ **Hands-On Lab- Modeling Impact Craters-** In this lab, students analyze how mass affects the appearance of impact craters, and model the process of a comet or meteor colliding with a planet.	
		Evaluate	• **Lesson Self Check** (pp. 189-191)- Can You Explain It- Revisit • **Make Your Own Study Guide** (p. 191) • **Checkpoint Questions** (pp. 190-191)	• **Can You Explain It?** Revisit • **Checkpoint Questions** • **Make Your Own Study Guide** • **Unit 4- Lesson 1 Quiz**	
	Lesson 4.2 Gravity and Orbits In this lesson, you will describe models of planetary motion and to explain Kepler's laws of motion and Newton's laws of gravitation. **Vocabulary**: orbit ellipse focus axis eccentricity gravity force	**Engage**	• **Phenomenon: Can You Explain It?-** Why can we sometimes see Mercury and Venus as they move in front of the sun? (p. 192)		**ESRT:** • Equations: Eccentricity (p. 1)
		Explore/ Explain	• **Exploration 1-** Planetary Movement (pp. 193-196) • **Exploration 2-** Planetary Motion (pp. 197-198) • **Exploration 3-** Gravity and the Motion of Planets (pp. 199-201)	• **Lesson 2- Gravity and Orbits PPT (editable)** • **Exploration 1: Hands-On Lab- Modeling Orbits-** In this lab, students use a model to study the elliptical orbits of planets. • **Exploration 2: Hands-On Lab- Moons of Jupiter-** In this lab, students learn how Kepler's third law explains the orbits of the moons of Jupiter.	
		Elaborate	• **Continue Your Exploration- Guided Research:** Space Junk (p. 202)	• **Continue Your Exploration:** ○ NASA Scientist ○ The International Space Station	
		Evaluate	• **Lesson Self Check** (pp. 203-205)- Can You Explain It- Revisit • **Make Your Own Study Guide** (p. 205) • **Checkpoint Questions** (pp. 204-205)	• **Can You Explain It?** Revisit • **Checkpoint Questions** • **Make Your Own Study Guide** • **Unit 4- Lesson 2 Quiz**	
	Lesson 4.3 Earth and the Sun In this lesson, you will explain how the interaction of solar energy with Earth's systems affects those systems. **Vocabulary**: greenhouse gas sunspot precession insolation	**Engage**	• **Phenomenon: Can You Explain It?-** How and why has Earth's temperature changed over time? (p. 206)		Seasons and Ecliptic Simulator • Seasons and Ecliptic Simulator Observing the Moon and Sun: • New Moon Video • Full Moon Video Lunar Phases Simulation Moon Orbit Diagram
		Explore/ Explain	• **Exploration 1-** The Earth-Sun System (pp. 207-210) • **Exploration 2-** Solar Energy in Earth's Systems (pp. 211-213) • **Exploration 3-** Earth-Sun System and Climate Change (pp. 214-217)	• **Lesson 3- Earth and the Sun PPT (editable)** • **Exploration 1: Hands-On Lab- Earth-Sun Motion-** In this lab, students design an experiment to measure the movement of Earth, analyze the effectiveness of an experimental design, and demonstrate how shadows can be used to measure time. • **Exploration 2: Hands-On Lab- Positions of Sunrise and Sunset-** In this lab, students collect and analyze data describing	

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				the positions of sunrise and sunset, and then make predictions for future months.	Phases of the Moon Diagram Eclipses Diagram
		Elaborate	• **Continue Your Exploration- Data Analysis:** Glaciation Cycles (p. 218)	• **Continue Your Exploration:** ○ Milankovitch Cycles on Mars ○ Climate Feedback	
		Evaluate	• **Lesson Self Check** (pp. 219-221)- Can You Explain It- Revisit • **Make Your Own Study Guide** (p. 221) • **Checkpoint Questions** (pp. 220-221)	• **Can You Explain It?** Revisit • **Checkpoint Questions** • **Make Your Own Study Guide** • **Unit 4- Lesson 3 Quiz**	
	Thing Explainer		• **Worlds Around the Sun** (pp. 222-225)		
	Enrichment: Unit Connection Activities (Optional)		• **Physics-** Exploring Rotational Motion • ***Social Studies-** Traditional Calendars • ***Art-** Sun in Art		
	Unit Close		• **Synthesize the Unit** (p. 227) • **Driving Questions** (revisit) • **Practice and Review Questions** (pp. 227-228) • **Unit Project** Revisited (p. 228) • **Unit Performance Task** (p. 229)	• **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 4- Earth in the Solar System (Editable item bank available under Public Assignments in Castle Learning)

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	**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**	**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…*	**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	**Writing** • **Sentence Frames** - to begin a sentence- such as *Biodiversity is…* or *An example of competition is….* • **Cloze passages** with word banks • **Word banks**	**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

into your BPS Google Drive	• **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.	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	• **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.	• **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.	• **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

Special Education Modifications **Special Education students must have accommodations as per Individual Educational Plan (IEP)**	**Instructional** • **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 i**nteractive notebook** • Present complex **tasks in multiple ways** Provide **mnemonic strategies** for Living Environment concepts	**Technology:** • **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** **Other:** • Arrange seating for maximum engagement and minimum distraction • Accessible lab space (counter level)	**In Class Assessments** • 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

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BPS Science K-12 Schoology Folder: 9-12 Resources Earth Science Resources Curriculum Materials	**<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
Culturally and Linguistically Responsive Teaching (CLRT) in the Science Classroom	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 *