Strange New Planet

3rd – 5th Grade Alignment Document
National Resource Council Framework, Next Generation Science Standards, Common Core State Standards, and 21st Century Skills

WHAT STUDENTS DO: Explore a Model Planet to Discover New Features

Students find out how human curiosity in planetary exploration results in science questions, engineering solutions, and teamwork. This activity demonstrates how planetary features are discovered by the use of remote-sensing techniques. Students will experience the different phases in planetary exploration, including telescope observations, fly by missions, orbiters, landers, rovers…and their own ideas about human exploration. In this collection, this lesson provides one of the building blocks for understanding the relationship among science, engineering, technology, and teamwork, necessary to discovery and innovation.

NRC FRAMEWORK / NGSS CORE & COMPONENT QUESTIONS

HOW DO ENGINEERS SOLVE PROBLEMS?

NRC Core Question: ETS1: Engineering Design

What is a design for? What are the criteria and constraints of a successful solution?

NRC ETS1.A: Defining and Delimiting an Engineering Problem

INSTRUCTIONAL OBJECTIVES (IO)

Students will be able to

IO1: Use a physical model to investigate and describe how scientists and engineers use a variety of increasingly complex tools to explore our solar system

Last edited: March 31, 2016

1.0 About This Activity

The Mars lessons leverage *A Taxonomy for Learning, Teaching, and Assessing* by Anderson and Krathwohl (2001) (see *Section 4* and *Teacher Guide* at the end of this document). This taxonomy provides a framework to help organize and align learning objectives, activities, and assessments. The taxonomy has two dimensions. The first dimension, cognitive process, provides categories for classifying lesson objectives along a continuum, at increasingly higher levels of thinking; these verbs allow educators to align their instructional objectives and assessments of learning outcomes to an appropriate level in the framework in order to build and support student cognitive processes. The second dimension, knowledge, allows educators to place objectives along a scale from concrete to abstract. By employing Anderson and Krathwohl's (2001) taxonomy, educators can better understand the construction of instructional objectives and learning outcomes in terms of the types of student knowledge and cognitive processes they intend to support. All activities provide a mapping to this taxonomy in the Teacher Guide (at the end of this lesson), which carries additional educator resources. Combined with the aforementioned taxonomy, the lesson design also draws upon Miller, Linn, and Gronlund's (2009) methods for (a) constructing a general, overarching, instructional objective with specific, supporting, and measurable learning outcomes that help assure the instructional objective is met, and (b) appropriately assessing student performance in the intended learning-outcome areas through rubrics and other measures. Construction of rubrics also draws upon Lanz's (2004) guidance, designed to measure science achievement.

How Students Learn: Science in the Classroom (Donovan & Bransford, 2005) advocates the use of a research-based instructional model for improving students' grasp of central science concepts. Based on conceptual-change theory in science education, the 5E Instructional Model (BSCS, 2006) includes five steps for teaching and learning: Engage, Explore, Explain, Elaborate, and Evaluate. The Engage stage is used like a traditional warm-up to pique student curiosity, interest, and other motivation-related behaviors and to assess students' prior knowledge. The Explore step allows students to deepen their understanding and challenges existing preconceptions and misconceptions, offering alternative explanations that help them form new schemata. In Explain, students communicate what they have learned, illustrating initial conceptual change. The Elaborate phase gives students the opportunity to apply their newfound knowledge to novel situations and supports the reinforcement of new schemata or its transfer. Finally, the Evaluate stage serves as a time for students' own formative assessment, as well as for educators' diagnosis of areas of confusion and differentiation of further instruction. This five-part sequence is the organizing tool for the Mars instructional series. The 5E stages can be cyclical and iterative.

2.0 Instructional Objectives, Learning Outcomes, & Standards

Instructional objectives and learning outcomes are aligned with

- National Research Council's, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*
- Achieve Inc.'s, *Next Generation Science Standards (NGSS)*
- National Governors Association Center for Best Practices (NGA Center) and Council of Chief State School Officers (CCSSO)'s, *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and* Technical Subjects
- Partnership for 21st Century Skills, *A Framework for 21st Century Learning*

The following chart provides details on alignment among the core and component NGSS questions, instructional objectives, learning outcomes, and educational standards.

- Your **instructional objectives (IO)** for this lesson align with the NGSS Framework and NGSS.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO)**.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics** (see Teacher Guide at the end of this document).

Important Note: This lesson is color-coded to help teachers identify each of the three dimensions of NGSS. The following identifying colors are used: Practices are blue, Cross-Cutting Concepts are green, and Disciplinary Core Ideas are orange.

This color-coding is consistent with the NGSS Performance Expectations and Foundation Boxes.

Quick View of Standards Alignment:

The Teacher Guide at the end of this lesson provides full details of standards alignment, rubrics, and the way in which instructional objectives, learning outcomes, 5E activity procedures, and assessments were derived through, and align with, Anderson and Krathwohl's (2001) taxonomy of knowledge and cognitive process types. For convenience, a quick view follows:

HOW DO ENGINEERS SOLVE PROBLEMS?

NGSS Core Question: ETS1: Engineering Design

What is a design for? What are the criteria and constraints of a successful solution?

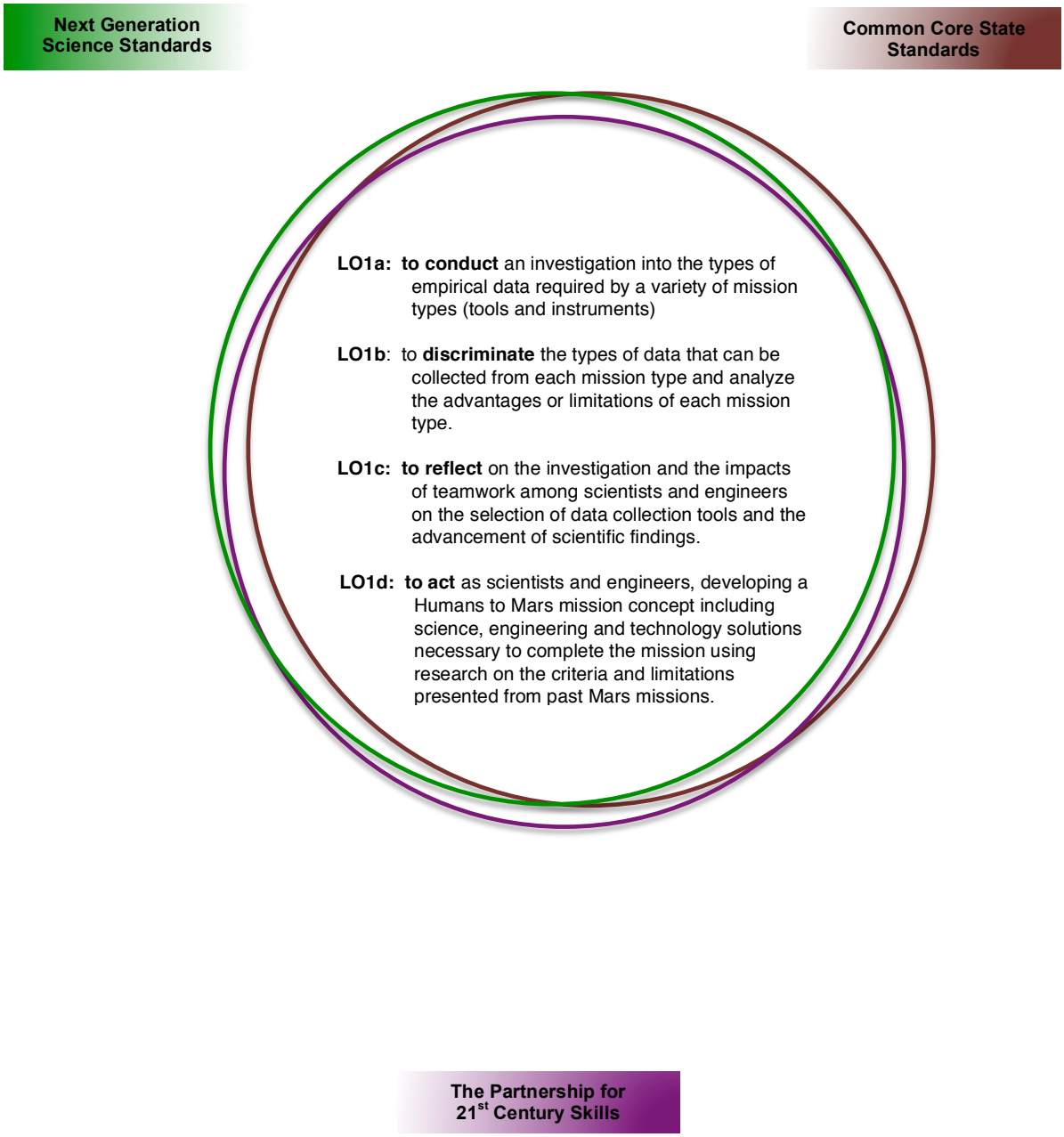
NGSS ETS1.A: Defining and Delimiting an Engineering Problem

Instructional Objective (IO) *Students will be able to:*	Learning Outcomes (LO) *Students will demonstrate the measurable abilities*	Standards *Students will address*
IO1: **Use a physical model to investigate and describe how scientists and engineers use a variety of increasingly complex tools to explore our solar system**	**LO1a:** to conduct an investigation into the types of empirical data required by a variety of mission types (tools and instruments) **LO1b:** to discriminate the types of data that can be collected from each mission type and analyze the advantages or limitations of each mission type. **LO1c:** to reflect on the investigation and the impacts of teamwork among scientists and engineers on the selection of data collection tools and the advancement of scientific findings **LO1d:** acting as scientists and engineers, develop a Humans to Mars mission concept including science, engineering and technology solutions necessary to complete the mission using research on the criteria and limitations presented from past Mars missions.	**DISCIPLINARY CORE IDEAS:** ETS1.A: Defining and Delimiting Engineering Problems **PRACTICES:** 1. Developing and Using Models 2. Planning and Carrying out Investigations 3. Analyzing and Interpreting Data 4. Constructing Explanations and Designing Solutions 5. Engaging in Argument from Evidence 6. Obtaining, Evaluating, and Communicating Information Scientific Investigations Use a Variety of Methods Scientific Knowledge is Based on Empirical Evidence Scientific Knowledge is Open to Revision in Light of New Evidence **CROSSCUTTING CONCEPTS:** 1. Systems and System Models Interdependence of Science, Engineering, and Technology Science is a Human Endeavor Science Addresses Questions about the Natural and Material World

Last edited: March 31, 2016

3.0 Learning Outcomes, NGSS, Common Core, & 21st Century Skills Connections

The connections diagram is used to organize the learning outcomes addressed in the lesson to establish where each will meet the Next Generation Science Standards, ELA Common Core Standards, and the 21st Century Skills and visually determine where there are overlaps in these documents.



4.0 Evaluation/Assessment

Use the *(L) Strange New Planet Rubric* as a formative and summative assessment, allowing students to improve their work and learn from mistakes during class. The rubric evaluates the activities using the Next Generation Science Standards, Common Core State Standards, and 21st Century Skills.

5.0 References

Achieve, Inc. (2013). *Next generation science standards*. Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS.

Anderson, L.W., & Krathwohl (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Bybee, R., Taylor, J., Gardner, A., Van Scotter, P., Carson Powell, J., Westbrook, A., Landes, N. (2006) *The BSCS 5E instructional model: origins, effectiveness, and applications.* Colorado Springs: BSCS.

Donovan, S. & Bransford, J. D. (2005). *How Students Learn: History, Mathematics, and Science in the Classroom.* Washington, DC: The National Academies Press.

Miller, Linn, & Gronlund. (2009). *Measurement and assessment in teaching*. Upper Saddle River, NJ: Pearson.

National Academies Press. (1996, January 1). *National science education standards*. Retrieved February 7, 2011 from http://www.nap.edu/catalog.php?record_id=4962

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: Authors.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

The Partnership for 21st Century Skills (2011). *A framework for 21st century learning.* Retrieved March 15, 2012 from http://www.p21.org

(I) Teacher Resource. Strange New Planet NGSS Alignment (1 of 3)

You will know the level to which your students have achieved the **Learning Outcomes**, and thus the **Instructional Objective(s)**, by using the suggested **Rubrics** below.

Related Standard(s)

This lesson supports the preparation of students toward achieving Performance Expectations using the Practices, Cross-Cutting Concepts and Disciplinary Core Ideas defined below:
(3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)

Next Generation Science Standards Alignment (NGSS)

Instructional Objective *Students will be able to*	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
IO1: Use a physical model to investigate and describe how scientists and engineers use a variety of increasingly complex tools to explore our solar system	**Developing and Using Models:** Compare models to identify common features and differences *(Reconnection to K-2 Condensed Practices)* **Planning and Carrying Out Investigations:** Evaluate appropriate methods and/or tools for collecting data. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Analyzing and Interpreting Data:** Record information (observations, thoughts, and ideas). *(Reconnection to K-2 Condensed Practices)* Use and share pictures, drawings, and/or writings of observations. *(Reconnection to K-2 Condensed Practices)* Use data to evaluate and refine design solutions.	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Systems and System Models:** A system can be described in terms of its components and their interactions. **Science is a Human Endeavor:** Most scientists and engineers work in teams.

	Constructing Explanations and Designing Solutions: Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. **Obtaining, Evaluating, and Communicating Information:** Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical Evidence:** Scientists use tools and technologies to make accurate measurements and observations. **Scientific Knowledge is Open to Revision in Light of New Evidence:** Science explanations can change based on new evidence.		**Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

(I) Teacher Resource. Strange New Planet NGSS Alignment (2 of 3)

Next Generation Science Standards Alignment (NGSS)

Learning Outcome *Students will be able to*	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
LO1a: conduct an investigation into the types of empirical data required by a variety of mission types (tools and instruments)	**Developing and Using Models:** Compare models to identify common features and differences *(Reconnection to K-2 Condensed Practices)* **Planning and Carrying Out Investigations:** Evaluate appropriate methods and/or tools for collecting data. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Analyzing and Interpreting Data:** Record information (observations, thoughts, and ideas). *(Reconnection to K-2 Condensed Practices)* Use and share pictures, drawings, and/or writings of observations. *(Reconnection to K-2 Condensed Practices)* Use data to evaluate and refine design solutions. **Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. **Engaging in Argument from Evidence:**	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Systems and System Models:** A system can be described in terms of its components and their interactions. **Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

	Construct and/or support an argument with evidence, data, and/or a model. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical Evidence:** Scientists use tools and technologies to make accurate measurements and observations. **Scientific Knowledge is Open to Revision in Light of New Evidence:** Science explanations can change based on new evidence.		
LO1b: Discriminate the types of data that can be collected from each mission type and analyze the advantages or limitations of each mission type.	**Developing and Using Models:** Compare models to identify common features and differences *(Reconnection to K-2 Condensed Practices)* **Analyzing and Interpreting Data:** Record information (observations, thoughts, and ideas). *(Reconnection to K-2 Condensed Practices)* Use and share pictures, drawings, and/or writings of observations. *(Reconnection to K-2 Condensed Practices)* Use data to evaluate and refine design solutions. **Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence,	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Systems and System Models:** A system can be described in terms of its components and their interactions. **Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

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LO1c: **Reflect on the investigation and the impacts of teamwork among scientists and engineers on the selection of data collection tools and the advancement of scientific findings**	**Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical Evidence:** Scientists use tools and technologies to make accurate measurements and observations. **Scientific Knowledge is Open to Revision in Light of New Evidence:**	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Science is a Human Endeavor:** Most scientists and engineers work in teams. **Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

	Science explanations can change based on new evidence.		
LO1d: Acting as scientists and engineers, develop a Humans to Mars mission concept including science, engineering and technology solutions necessary to complete the mission using research on the criteria and limitations presented from past Mars missions.	**Developing and Using Models:** Compare models to identify common features and differences *(Reconnection to K-2 Condensed Practices)* **Analyzing and Interpreting Data:** Use and share pictures, drawings, and/or writings of observations. *(Reconnection to K-2 Condensed Practices)* Use data to evaluate and refine design solutions. **Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. **Obtaining, Evaluating, and Communicating Information:** Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical**	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Systems and System Models:** A system can be described in terms of its components and their interactions. **Science is a Human Endeavor:** Most scientists and engineers work in teams. **Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

	Evidence: Scientists use tools and technologies to make accurate measurements and observations. **Scientific Knowledge is Open to Revision in Light of New Evidence:** Science explanations can change based on new evidence.		

(I) Teacher Resource. Strange New Planet NGSS Activity Alignment (3 of 3)

Next Generation Science Standards Activity Alignments (NGSS)

Activity	Phases of 5E Instructional Model	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
How Science and Engineering Come Together in Planetary Exploration	**Engage**	**Asking Questions and Defining Problems** Ask questions and/or identify questions that can be answered by investigations (Reconnection to K-2 Practice)	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.
How Engineering and Technology Support Science Questions (Student Worksheets A – E)	**Explore**	**Developing and Using Models:** Compare models to identify common features and differences *(Reconnection to K-2 Condensed Practices)* **Planning and Carrying Out Investigations:** Evaluate appropriate methods and/or tools for collecting data. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Analyzing and Interpreting Data:** Record information (observations, thoughts, and	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Systems and System Models:** A system can be described in terms of its

		ideas). *(Reconnection to K-2 Condensed Practices)* Use and share pictures, drawings, and/or writings of observations. *(Reconnection to K-2 Condensed Practices)* **Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical Evidence:** Scientists use tools and technologies to make accurate measurements and observations. **Scientific Knowledge is Open to Revision in Light of New Evidence:** Science explanations can change based on new evidence.		components and their interactions. **Science is a Human Endeavor:** Most scientists and engineers work in teams. **Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

How Engineering and Technology Support Answering Scientific Questions (Student Worksheet F)	**Explain**	**Developing and Using Models:** Compare models to identify common features and differences *(Reconnection to K-2 Condensed Practices)* **Analyzing and Interpreting Data:** Use data to evaluate and refine design solutions. **Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical Evidence:** Scientists use tools and technologies to make accurate measurements and observations. **Scientific Knowledge is Open to Revision in Light of New Evidence:** Science explanations can change based on new evidence.	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.
Planning a New Mission (Student Worksheet G)	**Elaborate**	**Asking Questions and Defining Problems:** Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. **Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other.

		and constraints of the design solution. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. **Obtaining, Evaluating, and Communicating Information:** Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical Evidence:** Scientists use tools and technologies to make accurate measurements and observations.	one meets the specified criteria for success or how well each takes the constraints into account.	Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Science is a Human Endeavor:** Most scientists and engineers work in teams. **Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.
Assessing Strengths and Weaknesses of Proposed Missions (Student Worksheet G, part 2)	**Evaluate**	**Developing and Using Models:** Compare models to identify common features and differences *(Reconnection to K-2 Condensed Practices)* **Analyzing and Interpreting Data:** Use data to evaluate and refine design solutions. **Constructing Explanations and Designing Solutions:** Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or	**ETS1.A Defining and Delimiting an Engineering Problem:** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Interdependence of Science, Engineering, and Technology:** Science and engineering involve the use of tools to observe and measure things. (Reconnection to K-2 Disciplinary Core Idea Connections Statement) Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Science is a Human Endeavor:** Most scientists and engineers work in teams.

		design a solution to a problem. **Engaging in Argument from Evidence:** Construct and/or support an argument with evidence, data, and/or a model. **Obtaining, Evaluating, and Communicating Information:** Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts. **Scientific Investigations Use a Variety of Methods:** Science methods are determined by questions. Science investigations use a variety of methods, tools, and techniques. **Scientific Knowledge is Based on Empirical Evidence:** Scientists use tools and technologies to make accurate measurements and observations. **Scientific Knowledge is Open to Revision in Light of New Evidence:** Science explanations can change based on new evidence.		**Science Addresses Questions about the Natural and Material World:** Science findings are limited to what can be answered with empirical evidence.

(J) Teacher Resource. Strange New Planet CCSS Alignment (1 of 2)

Common Core State Standards			
Instructional Objective *Students will be able to*	**Reading Standards for Informational Text (3-5)**	**Writing Standards (3-5)**	**Speaking and Listening Standards (3-5)**
IO1: **Use a physical model to investigate and describe how scientists and engineers use a variety of increasingly complex tools to explore our solar system**		**Text Types and Purposes:** **Grade 3:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. b. Develop the topic with facts, definitions, and details. c. Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information. d. Provide a concluding statement or section. **Grade 4:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). d. Use precise language and domain-	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

		specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Grade 5:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented.	a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

(J) Teacher Resource. Strange New Planet CCSS Alignment (2 of 2)

Common Core State Standards			
Learning Outcome *Students will be able to*	**Reading Standards for Informational Text (3-5)**	**Writing Standards (3-5)**	**Speaking and Listening Standards (3-5)**
LO1a: **conduct an investigation into the types of empirical data required by a variety of mission types (tools and instruments)**		**Research to Build and Present Knowledge:** **Grade 3:** Conduct short research projects that build knowledge about a topic. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **Grade 4:** Conduct short research projects that build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 4 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text"). **Grade 5:** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

		sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 5 Reading standards to informational texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]").	a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
LO1b: **to discriminate the types of data that can be collected from each mission**		**Text Types and Purposes:** **Grade 3:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic and group related	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and

type and analyze the advantages or limitations of each mission type.		information together; include illustrations when useful to aiding comprehension. b. Develop the topic with facts, definitions, and details. c. Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information. d. Provide a concluding statement or section. **Grade 4:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Grade 5:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other	texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

		information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Research to Build and Present Knowledge:** **Grade 3:** Conduct short research projects that build knowledge about a topic. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **Grade 4:** Conduct short research projects that build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. **Grade 5:** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.	**Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

LO1c: **to reflect on the investigation and the impacts of teamwork among scientists and engineers on the selection of data collection tools and the advancement of scientific findings.**		**Text Types and Purposes:** **Grade 3:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. b. Develop the topic with facts, definitions, and details. c. Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information. d. Provide a concluding statement or section. **Grade 4:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Grade 5:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to

		group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Research to Build and Present Knowledge:** **Grade 3:** Conduct short research projects that build knowledge about a topic. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **Grade 4:** Conduct short research projects that build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. **Grade 5:** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital	the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

		sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.	
LO1d: **acting as scientists and engineers, develop a Humans to Mars mission concept including science, engineering and technology solutions necessary to complete the mission using research on the criteria and limitations presented from past Mars missions.**	**Craft and Structure:** **Grade 3:** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area. Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. **Grade 4:** Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area. **Grade 5:** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area. **Integration of Knowledge and Ideas:** **Grade 3:** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). **Grade 4:** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. **Grade 5:** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.	**Text Types and Purposes:** **Grade 3:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. b. Develop the topic with facts, definitions, and details. c. Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information. d. Provide a concluding statement or section. **Grade 4:** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Grade 5:**	**Comprehension and Collaboration:** **Grade 3:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. e. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). f. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. g. Explain their own ideas and understanding in light of the discussion. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. **Grade 4:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned

		Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented. **Research to Build and Present Knowledge:** **Grade 3:** Conduct short research projects that build knowledge about a topic. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **Grade 4:** Conduct short research projects that build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 4 Reading standards to	roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion. **Grade 5:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

		informational texts (e.g., “Explain how an author uses reasons and evidence to support particular points in a text”). **Grade 5:** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 5 Reading standards to informational texts (e.g., “Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]”).	

(J) Teacher Resource. Strange New Planet 21st Century Skills Alignment

21st Century Skills		
Learning Outcomes *Students will demonstrate the measurable abilities*	**21st Century Skill**	**Grade 4 Benchmark**
LO1a: **to conduct an investigation into the types of empirical data required by a variety of mission types (tools and instruments)**	**Communication**	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.
	Critical Thinking and Problem Solving	Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others.
	Information and Communications Technology (ICT) Literacy	Students can give examples that demonstrate how technology extends the ability of people to observe and interact with the world including how people communicate, gain knowledge, and express ideas.
	Flexibility and Adaptability	Students can identify how improvements in scientific instruments can lead to new discoveries.
	Productivity and Accountability	Students identify a variety of tools and techniques that scientists use to gather scientific information depending on what it is they want to know and the circumstances under which data will be collected.
LO1b: **to discriminate the types of data that can be collected from each mission type and analyze the advantages or limitations of each mission type.**	**Critical Thinking and Problem Solving**	Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others.
	Communication	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.
	Information and Communications Technology (ICT) Literacy	Students can give examples that demonstrate how technology extends the ability of people to observe and interact with the world including how people communicate, gain knowledge, and express ideas.
	Flexibility and Adaptability	Students can identify how improvements in scientific instruments can lead to new discoveries.

	Productivity and Accountability	Students identify a variety of tools and techniques that scientists use to gather scientific information depending on what it is they want to know and the circumstances under which data will be collected.
LO1c: to reflect on the investigation and the impacts of teamwork among scientists and engineers on the selection of data collection tools and the advancement of scientific findings.	**Critical Thinking and Problem Solving**	Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others.
	Communication	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.
	Information and Communications Technology (ICT) Literacy	Students can give examples that demonstrate how technology extends the ability of people to observe and interact with the world including how people communicate, gain knowledge, and express ideas.
	Flexibility and Adaptability	Students can identify how improvements in scientific instruments can lead to new discoveries.
	Productivity and Accountability	Students identify a variety of tools and techniques that scientists use to gather scientific information depending on what it is they want to know and the circumstances under which data will be collected.
LO1d: acting as scientists and engineers, develop a Humans to Mars mission concept including science, engineering and technology solutions necessary to complete the mission using research on the criteria and limitations presented from past Mars missions.	**Critical Thinking and Problem Solving**	Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others.
	Communication	Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work.
	Collaboration	Students work collaboratively with others, both in small and large groups, in their science classroom.
	Flexibility and Adaptability	Students can identify how improvements in scientific instruments can lead to new discoveries.
	Information and Communications Technology (ICT) Literacy	Students can give examples that demonstrate how technology extends the ability of people to observe and interact with the world including how people communicate, gain knowledge, and express ideas.
	Productivity and Accountability	Students identify a variety of tools and techniques that scientists use to gather scientific information depending on what it is they want to know and the circumstances under which data will be collected.

(L) Teacher Resource. Strange New Planet NGSS Rubric (1 of 3)

Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):

Next Generation Science Standards Alignment (NGSS)

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a. to conduct an investigation into the types of empirical data required by a variety of mission types (tools and instruments)	Collects multiple quantitative and qualitative data sets for each type of mission and records the data clearly. Identifies thoughtful questions left unanswered by the data from earlier missions and attempts to explore answers to them in subsequent missions.	Collects multiple quantitative and qualitative data sets for each type of mission and records the data clearly. Identifies one thoughtful question left unanswered by the data from earlier missions and attempts to explore answers to it in subsequent missions.	Collects and records quantitative or qualitative data for each type of mission. Asks some questions about the data from earlier missions that that may or may not be related to missions.	Collects data from peers and asks questions unrelated to the missions presented.
LO1b: to discriminate the types of data that can be collected from each mission type and analyze the advantages or limitations of each mission type.	Clearly articulates how the level of detail and volume of data increases with the advances in technology (advancing mission types) and provides a thoughtful explanation of the advances and limitations presented for each mission.	States the level of detail and volume of data increases with the advances in technology (advancing mission types) and provides an explanation of the advances and limitations presented for each mission.	States the level of detail or volume of data increases with the advances in technology (advancing mission types) and provides an explanation of the advances or limitations presented for each mission.	States there is little difference between the types of data collected among the variety of missions and/or miscategorizes advances and limitations.
LO1c: to reflect on the investigation and the impacts of teamwork among scientists and engineers on the selection of data collection tools and the advancement of scientific findings.	Provides a detailed explanation of the interdependence of scientists and engineers. Citing appropriate evidence, specifically the types of tools that match the type of desired science, from the activity and personal experience to support the explanation.	Provides a detailed explanation of the interdependence of scientists and engineers. Citing appropriate evidence from the activity to support the explanation.	Provides an explanation of the interdependence of scientists and engineers. Citing evidence from the activity to support the explanation.	States scientists and engineers work together and attempts to cite evidence from the activity.
LO1d: acting as scientists and engineers, develop a Humans to Mars mission concept including science, engineering and technology solutions necessary to complete the mission using research on the criteria and limitations presented from past Mars missions.	Clearly defines a Mars mission concept that incorporates important scientific goals in addition to choosing appropriate technology options to investigate the science goals.	Defines a Mars mission concept that incorporates scientific goals in addition to choosing appropriate technology options to investigate the science goals.	Defines a Mars mission concept that incorporates a scientific goal in addition to choosing an appropriate technology option to investigate the science goal.	Attempts to identify a science goal and match it to a technology option.

(L) Teacher Resource. Strange New Planet CCSS Rubric (2 of 3)

Common Core – ELA

	Expert	Proficient	Intermediate	Beginner
Craft and Structure	Determines and uses domain-specific words and phases from text to accurately support ideas.	Determines and uses domain-specific words and phrases from text to support ideas.	Uses domain-specific words and phrases from text with occasional errors to support ideas.	Uses standard language to support ideas.
Integration of Knowledge and Ideas	Uses a combination of drawing, dictating, and writing to provide a description of the results of the experiment, supported with evidence from the experiment.	Uses a combination of drawing, dictating, and writing to describe the results of the experiment.	Uses a drawing, dictation, or writing to describe the results of the experiment.	Description of the result is based on prior knowledge or preconceptions.
Text Type and Purposes	Uses a combination of drawing, dictating, and writing to describe the results of the experiment, supported with facts about the experiments, and a closing statement about the experiment.	Uses drawing, dictating, or writing to describe the results of the experiment, supported with facts about the experiments, and a closing statement about the experiment.	Uses drawing, dictating, or writing to describe the results of the experiment and is supported with facts about the experiments.	Uses drawing, dictating, or writing to provide the results of the experiment.
Research to Build and Present Knowledge	Recalls relevant information from experience; summarizes information in finished work; draws evidence from informational texts to support analysis, reflection, and research.	Recalls relevant information from experience; draws evidence from informational texts to support analysis, reflection, and research.	Recalls information from experience; draws evidence from informational texts to support analysis, reflection, and research.	Recalls information from experience.
Comprehension and Collaboration	Clearly articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Extremely prepared drawing from experiences. Asks clarifying questions to ensure full understanding of content. Articulates own ideas related to the discussion and connects others ideas to own.	Articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Prepared for discussion by drawing from experiences. Asks questions. Articulates own ideas related to the discussion.	Interested in collaborative discussion. Asks questions. Articulates own ideas related to the discussion.	Interested in collaboration with peers.

(L) Teacher Resource. Strange New Planet 21st Century Skills Rubric (3 of 3)

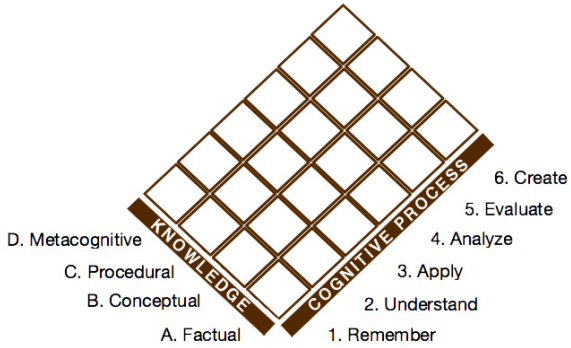
Partnership for 21st Century Skills

	Expert	Proficient	Intermediate	Beginner
Effectiveness of collaboration with team members and class.	Extremely interested in collaborating in the group. Actively provides solutions to problems, listens to suggestions from others, and attempts to ensure everyone has a contribution.	Extremely Interested in collaborating in the group. Actively provides suggestions and occasionally listens to suggestions from others.	Interested in collaborating in the group. Listens to suggestions from peers and attempts to use them. Occasionally provides suggestions in group discussion.	Interested in collaborating in the group or spend majority of the time off topic.
Effectiveness of Critical Thinking and Problem Solving	Develops detailed verbal explanations based on experimental evidence. Compares explanations to those made by peers and relates them to their new understandings.	Develops detailed verbal explanations based on experimental evidence. Relates them to their new understandings.	Develops verbal explanations. Relates explanation to their new understandings.	Attempts to explain the design based on own preconceived understanding or generally agree with the explanations provided by the group.
Effectiveness in Communication	Demonstrates the understanding that this is a simple model of how we explore, not all missions are represented, and communication is rooted in reality, not make-believe.	Demonstrates the understanding that this is a simple model of a how we explore, not all missions are represented, and may pretend the simulation is real, but majority of the experiment is rooted in reality.	Demonstrates the understanding that this is a simple model of how we explore and may pretend the simulation is real, but majority of the experiment is rooted in reality.	Plays during the simulation regardless of the goals of the task
Effectiveness of Productivity and Accountability	Accurately collects data and able to demonstrate good practices for data collection such as using standard measurement with correct tools **and** identifying common sources of error.	Accurately collects data and able to demonstrate good practices for data collection such as using standard measurement with correct tools **or** identifying common sources of error.	Accurately collects data.	Records data other team members have collected.
Effective use of Information and Communications Technology (ICT) Literacy	Gives examples that demonstrate how technology extends the ability of people to observe and understand planets including how people communicate, gain knowledge, and express ideas.	Gives examples that demonstrate how technology extends the ability of people to observe and understand planets including how people communicate, gain knowledge, or express ideas.	Gives one example to demonstrate how technology extends the ability of people to observe and understand planets.	Examples are based on preconceived misconceptions about the use of technology to extend the knowledge of people.

Effectiveness of Flexibility and Adaptability	Can accurately identify examples from the activity on how improvements in scientific instruments can lead to new discoveries.	Can accurately identify at least one example from the activity on how improvements in scientific instruments can lead to new discoveries.	Can identify at least one example from the activity on how improvements in scientific instruments can lead to more information.	Claims all scientific instruments will yield the same information or bases examples on preconceived misconceptions.

(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (1 of 3)

This lesson adapts Anderson and Krathwohl's (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s). Activity procedures and assessments are designed to support the target knowledge/cognitive process.

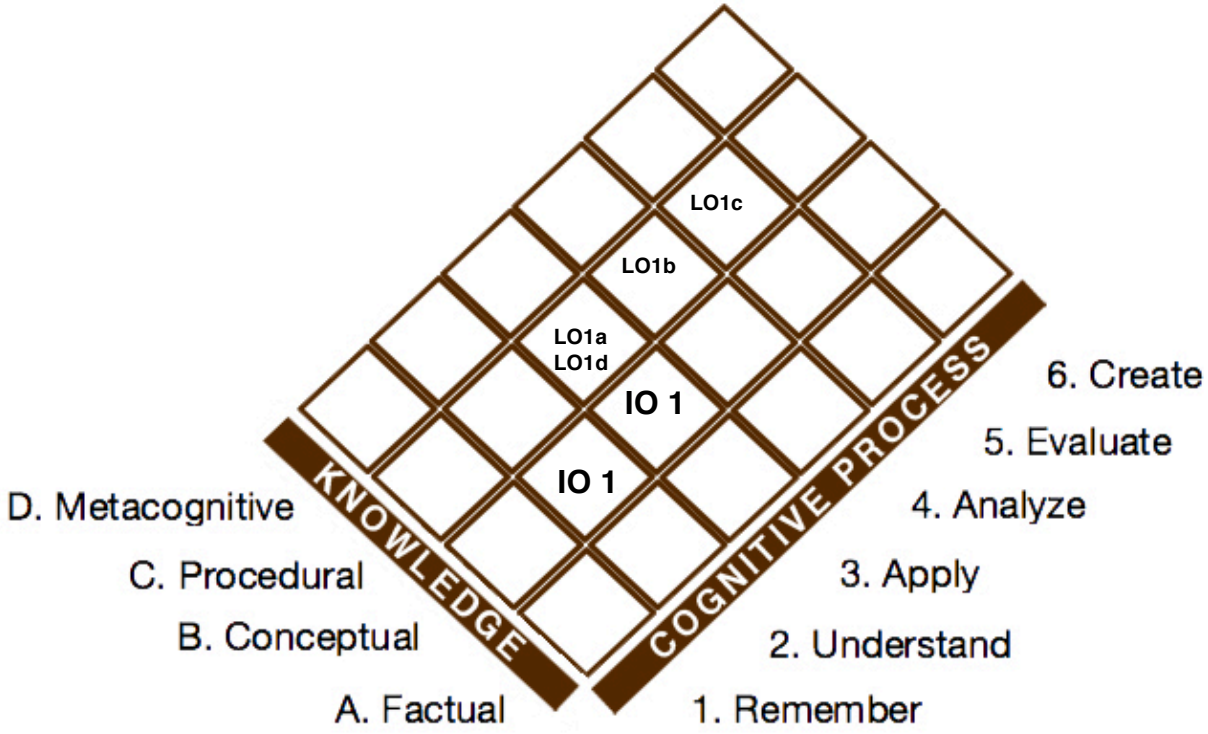


Knowledge	Cognitive Process
A. Factual **Aa:** Knowledge of Terminology **Ab:** Knowledge of Specific Details & Elements **B. Conceptual** **Ba:** Knowledge of classifications and categories **Bb:** Knowledge of principles and generalizations **Bc:** Knowledge of theories, models, and structures **C. Procedural** **Ca:** Knowledge of subject-specific skills and algorithms **Cb:** Knowledge of subject-specific techniques and methods **Cc:** Knowledge of criteria for determining when to use appropriate procedures **D. Metacognitive** **Da:** Strategic Knowledge **Db:** Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge **Dc:** Self-knowledge	**1. Remember** **1.1** Recognizing (Identifying) **1.2** Recalling (Retrieving) **2. Understand** **2.1** Interpreting (Clarifying, Paraphrasing, Representing, Translating) **2.2** Exemplifying (Illustrating, Instantiating) **2.3** Classifying (Categorizing, Subsuming) **2.4** Summarizing (Abstracting, Generalizing) **2.5** Inferring (Concluding, Extrapolating, Interpolating, Predicting) **2.6** Comparing (Contrasting, Mapping, Matching) **2.7** Explaining (Constructing models) **3. Apply** **3.1** Executing (Carrying out) **3.2** Implementing (Using) **4. Analyze** **4.1** Differentiating (Discriminating, distinguishing, focusing, selecting) **4.2** Organizing (Finding coherence, integrating, outlining, parsing, structuring) **4.3** Attributing (Deconstructing) **5. Evaluate** **5.1** Checking (Coordinating, Detecting, Monitoring, Testing) **5.2** Critiquing (Judging) **6. Create** **6.1** Generating (Hypothesizing) **6.2** Planning (Designing) **6.3** Producing (Constructing)

(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (2 of 3)

IO1: Use a physical model **to investigate and describe** how scientists and engineers use a variety of increasingly complex tools to explore our solar system (3.1, 2.7; Bc)

- **LO1a.** **to conduct** an investigation into the types of empirical data required by a variety of mission types (tools and instruments) (3.1; Cb)
- **LO1b.** **to discriminate** the types of data that can be collected from each mission type and analyze the advantages or limitations of each mission type. (4.1; Cc)
- **LO1c.** **to reflect** on the investigation and the impacts of teamwork among scientists and engineers on the selection of data collection tools and the advancement of scientific findings. (5.2; Cb)
- **LO1d.** **acting** as scientists and engineers, develop a Humans to Mars mission concept including science, engineering and technology solutions necessary to complete the mission using research on the criteria and limitations presented from past Mars missions. (3.1; Cb)



(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (3 of 3)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Below are the knowledge and cognitive process types students are intended to acquire per the instructional objective(s) and learning outcomes written for this lesson. The specific, scaffolded 5E steps in this lesson (see 5.0 Procedures) and the formative assessments (worksheets in the Student Guide and rubrics in the Teacher Guide) are written to support those objective(s) and learning outcomes. Refer to (M, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (M, 2 of 3) provides a visual description of the placement of learning outcomes that enable the overall instructional objective(s) to be met.

At the end of the lesson, students will be able

IO1: Use a physical model **to investigate and describe** how scientists and engineers use a variety of increasingly complex tools to explore our solar system
3.1: to carry out
2.7: to explain
Bc: Knowledge of theories, models, and structures

To meet that instructional objective, students will demonstrate the abilities:

LO1a: **to conduct** an investigation into the types of empirical data required by a variety of mission types (tools and instruments)
3.1: to conduct
Cb: Knowledge of subject-specific techniques and methods

LO1b: **to discriminate** the types of data that can be collected from each mission type and analyze the advantages or limitations of each mission type.
4.1: to descriminate
Cc: Knowledge of criteria for determining when to use appropriate procedures

LO1c: **to reflect** on the investigation and the impacts of teamwork among scientists and engineers on the selection of data collection tools and the advancement of scientific findings.
5.2: to critique
Cb: Knowledge of subject-specific techniques and methods

LO1d: **acting** as scientists and engineers, develop a Humans to Mars mission concept including science, engineering and technology solutions necessary to complete the mission using research on the criteria and limitations presented from past Mars missions.
3.1: to carry out
Cb: Knowledge of subject-specific techniques and methods