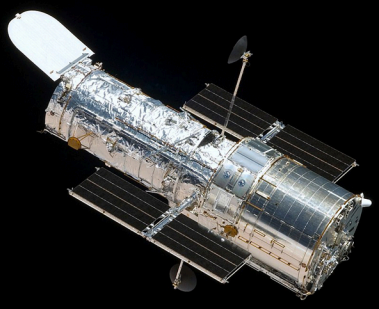
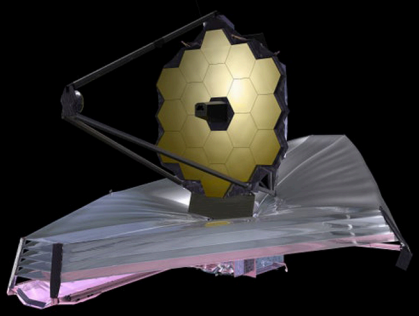
National Aeronautics and Space Administration





star party

NRC Framework High School Alignment Document

Star Party

High School NRC Framework for Science Education Alignment Document

WHAT STUDENTS DO: Use a model to resolve questions and debate.

Students use a model to create stars from a stellar nebula and track those stars through their life cycles in an attempt to resolve conflicts and answer questions from party attendees. They will collect evidence of star colors, luminosity, solar mass, lifespans, composition, and temperature along their journey.

NRC FRAMEWORK/NGSS CORE & COMPONENT QUESTIONS	INSTRUCTIONAL OBJECTIVES (IO)
WHAT IS THE UNIVERSE, AND WHAT IS EARTH'S PLACE IN IT? *NGSS Core Question: ESS1: Earth's Place in the Universe* **What is the universe, and what goes on in stars?** *NGSS ESS1.A: The Universe and Its Stars*	*Students will be able to* **IO1: Compare competing arguments related to the life cycle of stars and evaluate empirical evidence collected as a scientific way of knowing.**

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1.0 About This Activity

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. The 5E stages can be cyclical and iterative.

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2.0 Instructional Objectives, Learning Outcomes, Standards, & Rubrics

Visit https://infiniscope.org/lesson/star-party/ for access to the digital learning experience, lesson plans, standards alignment documents, and additional resources.

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*
- National Governors Association Center for Best Practices (NGA Center) and Council of Chief State School Officers (CCSSO)'s, *Common Core State Standards for Mathematics*
- Partnership for 21st Century Skills, *A Framework for 21st Century Learning*

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

- Your **instructional objectives (IO)** for this lesson align with the NRC Framework.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO),** also aligned with the NRC Framework.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics**.

Important Note: This lesson is color-coded to help teachers identify each of the three dimensions of the NRC Framework. 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 NRC Framework for K-12 Science Education.

Quick View of Standards Alignment:

This alignment document provides full details of the way in which instructional objectives, learning outcomes, 5E activity procedures, and rubric assessments were derived through, and align with the NRC Framework for K-12 Education. For convenience, a quick view follows:

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WHAT IS THE UNIVERSE, AND WHAT IS EARTH'S PLACE IN IT?

NGSS Core Question: ESS1: Earth's Place in the Universe

What is the universe, and what goes on in stars?

NGSS ESS1.A: The Universe and Its Stars

Instructional Objective *Students will be able to*	**Learning Outcomes** *Students will demonstrate the measurable abilities*	**Standards** *Students will address*
IO1: **Compare competing arguments related to the life cycle of stars and evaluate empirical evidence collected as a scientific way of knowing.**	**LO1a: Generate procedures to effectively use a stellar life cycle model in order to collect empirical evidence.** **LO1b: Use the HR diagram to model and explain the relationships between stellar mass and the star's luminosity and temperature.** **LO1c: Use a model to support or refute a claim about the relationships between the mass of a star (such as the Sun), it's color, and the lifetime of that star.** **LO1d: Model and explain the life cycle of a star and its relationship to the origin and process of element formation in a solar system.** **LO1e: Explain the purpose, benefits, and limitations of the model in describing the sun's life cycle.**	**PRACTICES:** 1. **Developing and Using Models** 2. **Planning and Carrying Out Investigations** 3. **Analyzing and Interpreting Data** 4. **Using Mathematics and Computational Thinking** 5. **Constructing Explanations and Designing Solutions** 6. **Engaging in Argument from Evidence** **DISCIPLINARY CORE IDEAS:** **ESS1.A: The Universe and its Stars** **CROSSCUTTING CONCEPTS:** 1. **Patterns** 2. **Scale, Proportion, and Quantity** 3. **Cause and Effect** 4. **System and Systems Models**

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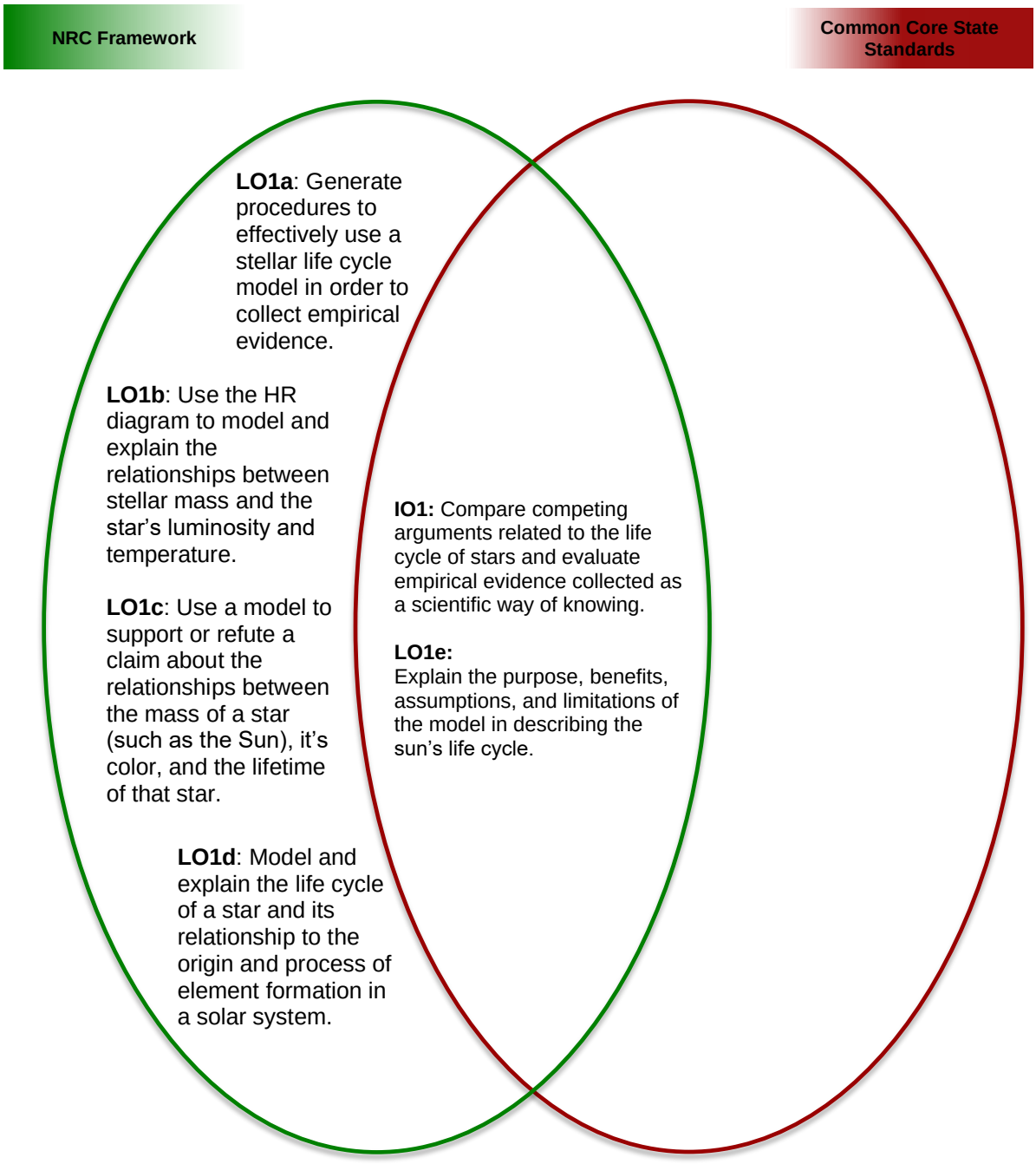
3.0 Instructional Objective, NGSS, Common Core, & 21st Century Skills Connections

The connections diagram is used to organize the instructional objective addressed in the lesson to establish where it will meet the Next Generation Science Standards, Common Core Standards, and the 21st Century Skills and visually determine where there are overlaps in these documents. See Common Core Alignment Document and 21st Century Skills Alignment Document for details on their specific alignments.



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4.0 Evaluation/Assessment

Use the *(N) Star Party Alignment 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 NRC Framework.

5.0 References

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.

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(M) Teacher Resource. Star Party NRC 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.

NRC Framework for K-12 Science Education			
Instructional Objective	**Science and Engineering Practices Benchmark by Grade 12**	**Disciplinary Core Idea Grade Band Endpoints**	**Crosscutting Concepts**
IO1: **Compare competing arguments related to the life cycle of stars and evaluate empirical evidence collected as a scientific way of knowing.**	**Engaging in Argument from Evidence** Construct a scientific argument showing how data support a claim. Identify possible weaknesses in scientific arguments, appropriate to the students' level of knowledge, and discuss them using reasoning and evidence.	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.

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(M) Teacher Resource. Star Party NRC Alignment (2 of 3)

NRC Framework for K-12 Science Education			
Learning Outcomes	**Science and Engineering Practices Benchmark by Grade 12**	**Disciplinary Core Idea Grade Band Endpoints**	**Crosscutting Concepts**
LO1a: **Generate procedures to effectively use a stellar life cycle model in order to collect empirical evidence.**	**Planning and Carrying Out Investigations** Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded. Decide how much data are needed to produce reliable measurements and consider any limitations on the precision of the data.	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.
LO1b: **Use the HR diagram to model and explain the relationships between stellar mass and the star's luminosity and temperature.**	**Developing and Using Models** Use (provided) computer simulations as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye. **Constructing Explanations and Designing Solutions** Construct their own explanations of phenomena using their knowledge of accepted scientific theory and linking it to models and evidence.	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced. **Cause and effect** Students argue from evidence when attributing an observed phenomenon to a specific cause.

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	Offer causal explanations appropriate to their level of scientific knowledge.	Earth.	
LO1c: **Use a model to support or refute a claim about the relationships between the mass of a star (such as the Sun), it's color, and the lifetime of that star.**	**Developing and Using Models** Use (provided) computer simulations as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye. **Analyzing and Interpreting Data** Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis. Recognize when data are in conflict with expectations and consider what revisions in the initial model are needed. **Constructing Explanations and Designing Solutions** Construct their own explanations of phenomena using their knowledge of accepted scientific theory and linking it to models and evidence. Offer causal explanations appropriate to their level of scientific knowledge. **Engaging in Argument from Evidence** Construct a scientific argument showing how data support a claim. Identify possible weaknesses in scientific arguments, appropriate to the	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced. **Cause and effect** Students argue from evidence when attributing an observed phenomenon to a specific cause.

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	students' level of knowledge, and discuss them using reasoning and evidence.		
LO1d: **Model and explain the life cycle of a star and its relationship to the origin and process of element formation in a solar system.**	**Developing and Using Models** Use (provided) computer simulations as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye. **Analyzing and Interpreting Data** Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis. Recognize when data are in conflict with expectations and consider what revisions in the initial model are needed. **Constructing Explanations and Designing Solutions** Construct their own explanations of phenomena using their knowledge of accepted scientific theory and linking it to models and evidence. Offer causal explanations appropriate to their level of scientific knowledge.	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced. **Cause and effect** Students argue from evidence when attributing an observed phenomenon to a specific cause.
LO1e: **Explain the purpose, benefits, and limitations of the model in**	**Developing and Using Models** Discuss the limitations and precision of a model as the representation of a system, process, or design and suggest ways in which the model might be improved to better fit	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the	**Scale, Proportion, and Quantity** Students acquire the ability as well to move back and forth between models at various scales, depending on the question being considered. They should develop a sense of the powers-

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describing the sun's life cycle.	available evidence or better reflect a design's specifications. Refine a model in light of empirical evidence or criticism to improve its quality and explanatory power. **Using Mathematics and Computational Thinking** Recognize that computer simulations are built on mathematical models that incorporate underlying assumptions about the phenomena or systems being studied. **Constructing Explanations and Designing Solutions** Construct their own explanations of phenomena using their knowledge of accepted scientific theory and linking it to models and evidence. Offer causal explanations appropriate to their level of scientific knowledge.	Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	of-10 scales and what phenomena correspond to what scale, from the size of the nucleus of an atom to the size of the galaxy and beyond. **System and System Models** By high school, students should also be able to identify the assumptions and approximations that have been built into a model and discuss how they limit the precision and reliability of its predictions.

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(M) Teacher Resource. Star Party NRC Individual Activity Alignment (3 of 3)

NRC Framework Activity Alignments				
Activity	**Phases of 5E Instructional Model**	**Science and Engineering Practices Benchmark by Grade 12**	**Disciplinary Core Idea Grade Band Endpoints**	**Crosscutting Concepts**
Eyes on Exoplanets	**Engage**			
Star Party Exploratory Activity	**Explore / Explain**	**Developing and Using Models** Use (provided) computer simulations as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye. **Planning and Carrying Out Investigations** Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded. Decide how much data are needed to produce reliable measurements and consider any limitations on the precision of the data. **Analyzing and Interpreting Data** Analyze data systematically, either to look for salient patterns or to test whether data are consistent with an initial hypothesis.	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced. **Cause and effect** Students argue from evidence when attributing an observed phenomenon to a specific cause. **Scale, Proportion, and Quantity** Students acquire the ability as well to move back and forth between models at various scales, depending on the question being considered. They should develop a sense of the powers-of-10 scales and what phenomena correspond to what scale, from the size of the nucleus of

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		Recognize when data are in conflict with expectations and consider what revisions in the initial model are needed. **Constructing Explanations and Designing Solutions** Construct their own explanations of phenomena using their knowledge of accepted scientific theory and linking it to models and evidence. Offer causal explanations appropriate to their level of scientific knowledge. **Engaging in Argument from Evidence** Construct a scientific argument showing how data support a claim. Identify possible weaknesses in scientific arguments, appropriate to the students' level of knowledge, and discuss them using reasoning and evidence.		an atom to the size of the galaxy and beyond.
(C) Considering Alternatives	**Elaborate**	**Constructing Explanations and Designing Solutions** Construct their own explanations of phenomena using their knowledge of accepted scientific theory and linking it to models and evidence. Offer causal explanations appropriate to their level of scientific knowledge. **Engaging in Argument from Evidence** Construct a scientific argument showing how data support a claim.	**PS2.B: Types of Interactions** There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—for example, Earth and the sun.	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced. **Cause and effect** Students argue from evidence when attributing an observed phenomenon to a specific cause.

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		Identify possible weaknesses in scientific arguments, appropriate to the students' level of knowledge, and discuss them using reasoning and evidence.		
(D) Resolve the Star Party Conflict	**Evaluate**	**Engaging in Argument from Evidence** Construct a scientific argument showing how data support a claim. Identify possible weaknesses in scientific arguments, appropriate to the students' level of knowledge, and discuss them using reasoning and evidence.	**ESS1.A: The Universe and Its Stars** The star called the sun is changing and will burn out over a life span of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Patterns** Students should recognize that different patterns may be observed at each of the scales at which a system is studied. Thus classifications used at one scale may fail or need revision when information from smaller or larger scales is introduced.

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(N) Teacher Resource. Star Party NRC Alignment Rubric

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

NRC Framework for Science Education Alignment

Instructional Objective	Expert	Proficient	Intermediate	Beginner
IO1: Compare competing arguments related to the life cycle of stars and evaluate empirical evidence collected as a scientific way of knowing.	Fully articulates the differences between a personal way of knowing vs a scientific way of knowing and includes examples from the Star Party exploration to support these differences. The description of the star life cycle includes mass of the star, lifespan, color of stars, and differences in end stages based on the mass of the star.	Articulates the primary difference between a personal way of knowing vs a scientific way of knowing and includes examples from the Star Party exploration to support this difference. The description of the star life cycle includes mass of the star, lifespan, color of stars, and differences in end stages based on the mass of the star.	Articulates the primary difference between a personal way of knowing vs a scientific way of knowing. The description of the star life cycle includes some of the following: mass of the star, lifespan, color of stars, and differences in end stages based on the mass of the star.	Makes a claim that either Pete or Gene is correct. Description of the star life cycle focuses primarily on death stage of a star.

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1e: Explain the purpose, benefits, assumptions, and limitations of the model in describing the sun's life cycle.	***Fully*** describes the use of models to simulate and predict phenomena, including examples of the benefits, assumptions, ***and*** limitations from stellar life cycle simulation.	Describes the use of models to simulate and predict phenomena, including examples of the benefits, assumptions, ***and*** limitations from stellar life cycle simulation.	Describes the use of models to simulate and predict phenomena, including examples of the benefits, assumptions, ***or*** limitations from stellar life cycle simulation.	Explains this is a computer model that simulates star birth and death.

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