



moon phases



Phases of the moon

Middle School NRC Framework for Science Education Alignment Document



WHAT STUDENTS DO: Use a model to reprogram a “telescope” to clear photos

Students use a model to identify inaccuracies in LuCIA’s coding. They will need to successfully sequence a variety of Moon phase diagrams to “Reprogram” her code. Students will test the new code to determine the clarity of galaxy image and reprogram until a clear image is achieved.

NRC FRAMEWORK/NGSS CORE & COMPONENT QUESTIONS

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

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

What are the predictable patterns caused by Earth’s movement in the solar system?

ESS1.B: Earth and the Solar System

INSTRUCTIONAL OBJECTIVES (IO)

Students will be able to

IO1: Use a model to generate and explain the phenomenon of moon phase sequence (effect) and the arrangement/orbit of the Sun, Earth, Moon system (cause).

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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/phases-of-the-moon/> for access to the digital learning experience 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*

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 are the predictable patterns caused by Earth's movement in the solar system?

ESS1.B: Earth and the Solar System

Instructional Objective <i>Students will be able to</i>	Learning Outcomes <i>Students will demonstrate the measurable abilities</i>	Standards <i>Students will address</i>
<p>IO1: Use a model to generate and explain the phenomenon of moon phase sequence (effect) and the arrangement/orbit of the Sun, Earth, Moon system (cause).</p>	<p>LO1a: Ask questions from observation of phenomena in order to identify the cause and effect relationship of the Sun, Earth, and Moon arrangement in phases of the moon.</p> <p>LO1b: Use a model to explore and explain the cause and effect relationship of the view from Earth, reflection of Sun's radiation, and the pattern of Moon phases.</p> <p>LO1c: Use a model to explore and explain the cause and effect relationship between the arrangement of the Sun, Earth, and Moon and the pattern of Moon phases.</p>	<p>PRACTICES:</p> <ol style="list-style-type: none"> 1. Asking Questions and Defining Problems 2. Developing and Using Models 3. Constructing Explanations and Designing Solutions 4. Obtaining, Evaluating, and Communicating Information <p>DISCIPLINARY CORE IDEAS: ESS1.A: The Universe and its Stars</p> <p>CROSSCUTTING CONCEPTS:</p> <ol style="list-style-type: none"> 1. Patterns 2. Cause and Effect

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3.0 Evaluation/Assessment

Use the *(N) Phases of the Moon 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.

4.0 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.
- 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.
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(M) Teacher Resource. Phases of the Moon 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
<p>IO1: Use a model to generate and explain the phenomenon of moon phase sequence (effect) and the arrangement/orbit of the Sun, Earth, Moon system (cause).</p>	<p>Developing and Using Models Use (provided) computer simulations or simulations developed with simple simulation tools as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye.</p> <p>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.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Patterns Recognize, classify, and record patterns in the phenomena they observe.</p> <p>Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>

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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
<p>LO1a: Ask questions from observation in order to identify the cause and effect relationship of the Sun, Earth, and Moon arrangement in phases of the moon.</p>	<p>Asking Questions and Defining Problems Note features, patterns, or contradictions in observations and ask questions about them.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Patterns Recognize, classify, and record patterns in the phenomena they observe.</p> <p>Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>
<p>LO1b: Use a model to explore and explain the cause and effect relationship view from Earth, reflection of Sun's radiation, and the pattern of Moon phases.</p>	<p>Developing and Using Models Use (provided) computer simulations or simulations developed with simple simulation tools as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye.</p> <p>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.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Patterns Recognize, classify, and record patterns in the phenomena they observe.</p> <p>Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>

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<p>LO1c: Use a model to explore and explain the cause and effect relationship between the arrangement of the Sun, Earth, and Moon and the pattern of Moon phases.</p>	<p>Developing and Using Models Use (provided) computer simulations or simulations developed with simple simulation tools as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye.</p> <p>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.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Patterns Recognize, classify, and record patterns in the phenomena they observe.</p> <p>Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>
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(M) Teacher Resource. Phases of the Moon 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
<p>The Moon and Libration</p> <p>(A) Moon Phases Observations Recording Sheet</p>	<p>Engage</p>	<p>Asking Questions and Defining Problems Note features, patterns, or contradictions in observations and ask questions about them.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Patterns Recognize, classify, and record patterns in the phenomena they observe.</p> <p>Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>
<p>Phases of the Moon Exploratory Activity</p> <p>(B) Phases Recording Sheet</p> <p>(C) Answers to My Questions Recording Sheet</p>	<p>Explore / Explain</p>	<p>Developing and Using Models Use (provided) computer simulations or simulations developed with simple simulation tools as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye.</p> <p>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.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Patterns Recognize, classify, and record patterns in the phenomena they observe.</p> <p>Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>

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<p>(D) Answering Open Questions</p>	<p>Elaborate</p>	<p>Obtaining, Evaluating, and Communicating Information Read scientific and engineering text, including tables, diagrams, and graphs, commensurate with their scientific knowledge and explain the key ideas being communicated.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Patterns Recognize, classify, and record patterns in the phenomena they observe. Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>
<p>(E) Phases of the Moon Evaluation</p>	<p>Evaluate</p>	<p>Developing and Using Models Use (provided) computer simulations or simulations developed with simple simulation tools 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.</p>	<p>ESS1.A: The Universe and Its Stars Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</p>	<p>Cause and Effect: Mechanisms and Prediction Asking about cause-and-effect relationships in the systems they are studying, particularly when something occurs that is, for them, unexpected.</p>

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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: Use a model to generate and explain the phenomenon of moon phase sequence (effect) and the arrangement/orbit of the Sun, Earth, Moon system (cause).	Student accurately represents the arrangement of the Sun, Earth and Moon, the view from Earth, and the correct sequence of an assigned Moon phase <i>In text and diagrams</i> . Student articulates this is a natural phenomenon with a repeating pattern due to the illumination of the Moon by the Sun and the position of the Moon in orbit around the Earth.	Student accurately represents the arrangement of the Sun, Earth and Moon, the view from Earth, and the correct sequence of an assigned Moon phase . Student articulates this is a natural phenomenon with a repeating pattern due to the illumination of the Moon by the Sun and the position of the Moon in orbit around the Earth.	Student represents the arrangement of the Sun, Earth and Moon, the view from Earth, and the sequence of a Moon phase. Student articulates this is a natural phenomenon with a repeating pattern due to the illumination of the Moon by the Sun and the position of the Moon in orbit around the Earth.	Student represents the arrangement of the Sun, Earth and Moon, the view from Earth, and the sequence of different Moon phases and completes the fill in activity.

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(N) Teacher Resource. Phases of the Moon NRC Alignment Rubric (1 of 2)

Learning Outcome	Expert	Proficient	Intermediate	Beginner
<p>LO1b: Use a model to explore and explain the cause and effect relationship of the view from Earth, reflection of Sun's radiation, and the pattern of Moon phases.</p>	<p>Student accurately represents illumination of the Moon and the view from Earth patterns in all diagrams. Includes an explanation that half of the Moon is always lit from solar radiation, but our view from Earth and the position of the Moon will determine what phase we observe on Earth.</p>	<p>Student accurately represents illumination of the Moon and the view from Earth patterns in all diagrams. Includes an explanation that half of the Moon is always lit, but our view from Earth and the position of the Moon will determine what phase we observe on Earth.</p>	<p>Student represents illumination of the Moon and the view from Earth patterns in at least one diagram. Includes an explanation that half of the Moon is lit.</p>	<p>Student discusses that half of the Moon is lit.</p>
<p>LO1c: Use a model to explore and explain the cause and effect relationship between the arrangement of the Sun, Earth, and Moon and the pattern of Moon phases.</p>	<p>Student accurately represents the arrangement of the Sun, Earth, and Moon in all diagrams. Description includes references to the model with different Moon phases viewed from Earth due to movement of the Moon during the 28 days as the Moon orbits Earth.</p>	<p>Student accurately represents the arrangement of the Sun, Earth, and Moon in all diagrams. Description includes references to the model with different Moon phases viewed from Earth.</p>	<p>Student represents the arrangement of the Sun, Earth, and Moon in all diagrams. Description includes references to different Moon phases viewed from Earth.</p>	<p>Student represents the arrangement of the Sun, Earth, and Moon in all diagrams.</p>

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