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).

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University’s Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University’s Mars Education Program. The lesson and its’ associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

Last edited: November 1, 2019
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.
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


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:
**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

<table>
<thead>
<tr>
<th>Instructional Objective</th>
<th>Learning Outcomes</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to</td>
<td>Students will demonstrate the measurable abilities</td>
<td>Students will address</td>
</tr>
</tbody>
</table>

**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).**

**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.

**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.

**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.

**PRACTICES:**
1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Constructing Explanations and Designing Solutions
4. Obtaining, Evaluating, and Communicating Information

**DISCIPLINARY CORE IDEAS:**
ESS1.A: The Universe and its Stars

**CROSSCUTTING CONCEPTS:**
1. Patterns
2. Cause and Effect
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


This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University’s Education Through eXploration (ETX) Center. Lesson formatting was adopted and adapted from Arizona State University’s Mars Education Program. The lesson and its’ associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

Last edited: November 1, 2019
PHASES OF THE MOON

Teacher Guide

Objective(s)

By using the suggested rubrics below, you will know the level to which your students have achieved the Learning Outcomes, and thus the Instructional Objectives.

(N) Teacher Resource: Phases of the Moon NRC Alignment (1 of 3)
## PHASES OF THE MOON

<table>
<thead>
<tr>
<th>Crosscutting Concepts</th>
<th>Disciplinary Core Ideas</th>
<th>Science and Engineering Practices</th>
<th>Benchmarks by Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRC Framework for K-12 Science Education</td>
<td>LO1a: The Universe and Its Patterns</td>
<td>LO1b: Moon and the Sun’s Reflection on Earth</td>
<td>LO1c: Moon and Earth</td>
</tr>
</tbody>
</table>
This lesson was prepared by Arizona State University's Education Through Exploration (ETX) Center. Lesson formatting was adapted and adopted from Arizona State University’s Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

This material is based upon work supported by NASA under cooperative agreement No. NNX16AD79A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration. This lesson was prepared by Arizona State University's Education Through Exploration (ETX) Center. Lesson formatting was adapted and adopted from Arizona State University’s Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

This lesson was prepared by Arizona State University's Education Through Exploration (ETX) Center. Lesson formatting was adapted and adopted from Arizona State University’s Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

This lesson was prepared by Arizona State University's Education Through Exploration (ETX) Center. Lesson formatting was adapted and adopted from Arizona State University’s Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.

This lesson was prepared by Arizona State University's Education Through Exploration (ETX) Center. Lesson formatting was adapted and adopted from Arizona State University’s Mars Education Program. The lesson and its associated materials may be photocopied and distributed freely for non-commercial purposes. Copyright 2016-2021.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Science and Engineering Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage</td>
<td>Explaining Explanations and Designing Solutions</td>
</tr>
<tr>
<td>Explain</td>
<td>Constructing Explanations and Developing and Using Models</td>
</tr>
<tr>
<td>Explore</td>
<td>Asking Questions and Defining Problems</td>
</tr>
<tr>
<td>Observe</td>
<td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, and explained using accepted scientific theories and models.</td>
</tr>
</tbody>
</table>

### Phase of the Moon

**Patterns**
- Recognize, classify, and record patterns in the phenomena they observe.

**Cause and Effect: Mechanisms and Prediction**
- Ask about cause-and-effect relationships in the systems they are studying, particularly when something unexpected occurs.

**Teacher Guide**

**Individual Activity Alignment**

**Phases of 5E Instructional Model**
- **Engage**: Asking Questions and Defining Problems
- **Explore**: Explaining Explanations and Designing Solutions
- **Explain**: Constructing Explanations and Developing and Using Models
- **Observe**: Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, and explained using accepted scientific theories and models.

**Crosscutting Concepts**

**Disciplinary Core Idea**

**Grade Band Endpoints**

**Science and Engineering Practices**

**Model**

**Activity**

**Benchmark by Grade**

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Idea</th>
<th>Grade Band Endpoints</th>
<th>Model</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking Questions and Defining Problems</td>
<td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, and explained using accepted scientific theories and models.</td>
<td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, and explained using accepted scientific theories and models.</td>
<td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, and explained using accepted scientific theories and models.</td>
<td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, and explained using accepted scientific theories and models.</td>
</tr>
<tr>
<td>Cause and Effect: Mechanisms</td>
<td>Developing and Using Models</td>
<td>Elaborate Questions Open Answering</td>
<td>Evaluate Phases of the Moon</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Expected. Something occurs that is expected, and the outcomes are predictable. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is predicted, and the outcomes are observable. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is unexpected. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is unexpected. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td></td>
</tr>
<tr>
<td>Expected. Something occurs that is expected, and the outcomes are predictable. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is predicted, and the outcomes are observable. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is unexpected. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is unexpected. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td></td>
</tr>
<tr>
<td>Expected. Something occurs that is expected, and the outcomes are predictable. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is predicted, and the outcomes are observable. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is unexpected. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td>Expected. Something occurs that is unexpected. Studying particular phenomena helps us identify cause-effect relationships in the systems they are part of.</td>
<td></td>
</tr>
</tbody>
</table>
### Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):

<table>
<thead>
<tr>
<th>NRC Framework for Science Education Alignment</th>
<th>Instructional Objective</th>
<th>Beginner</th>
<th>Intermediate</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NRC Framework for Science Education Alignment</strong></td>
<td><strong>Instructional Objective</strong></td>
<td><strong>Beginner</strong></td>
<td><strong>Intermediate</strong></td>
<td><strong>Expert</strong></td>
</tr>
<tr>
<td><strong>Teacher Resource</strong>: Phases of the Moon</td>
<td><strong>Alignment Rubric (1 of 2)</strong></td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### PHASES OF THE MOON

- **Teacher Guide**
- **Phases of the Moon**

**NRC Rubric Text**

1. **Beginner** (N) Teacher Resource. Phases of the Moon Resource (1 of 2)
   - Degenerate model of Earth, Moon, and Sun. Student represents the arrangement of the Sun, Earth, and Moon and the sequence of different Moon phases.
   - Student represents the arrangement of the Sun, Earth, and Moon and the sequence of an assigned Moon phase.
   - 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.

   - Degenerate model of Earth, Moon, and Sun. Student represents the arrangement of the Sun, Earth, and Moon and the sequence of different Moon phases.
   - Student accurately represents the arrangement of the Sun, Earth, and Moon and the view from Earth, and the sequence of an assigned Moon phase.
   - 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.

   - Degenerate model of Earth, Moon, and Sun. Student represents the arrangement of the Sun, Earth, and Moon and the sequence of different Moon phases.
   - Student accurately represents the arrangement of the Sun, Earth, and Moon and the view from Earth, and the sequence of an assigned Moon phase.
   - 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.

---

**NRC Framework for Science Education Alignment**

- **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 in text and diagrams. 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 correct sequence of different Moon phases and completes the fill-in activity.
Learning Outcome

<table>
<thead>
<tr>
<th>Beginner</th>
<th>Intermediate</th>
<th>Proficient</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO1a: 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.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>LO1b: 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.</td>
<td>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.</td>
<td>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.</td>
<td>Student represents the arrangement of the Sun, Earth, and Moon in all diagrams. Description includes references to different Moon phases viewed from Earth.</td>
</tr>
</tbody>
</table>

**Teacher Guide**

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