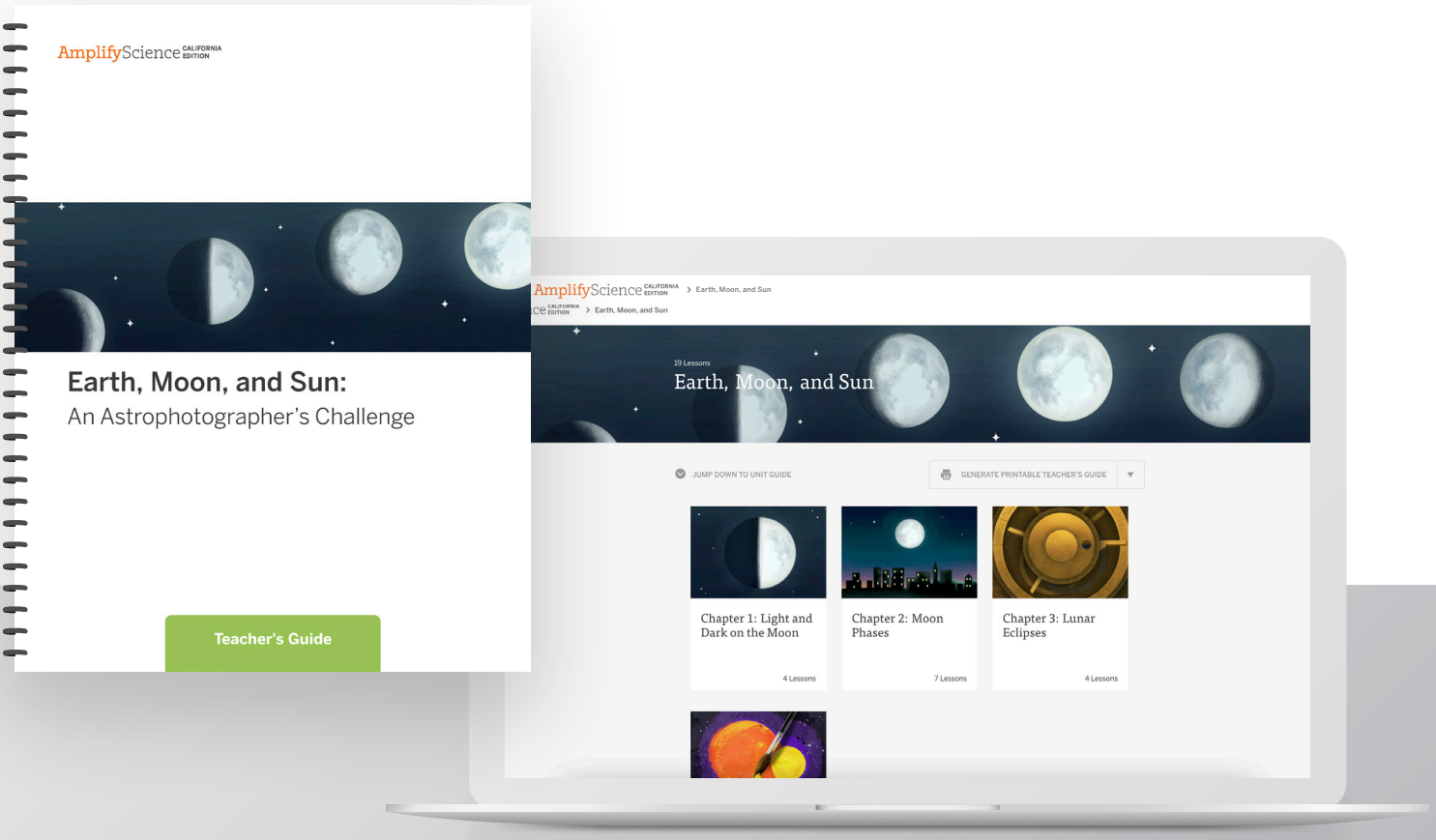
Amplify Science
CALIFORNIA

UNIT GUIDE

Earth, Moon, and Sun



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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Welcome to Earth, Moon, and Sun

Most students and many adults have no idea why the Moon looks different from night to night. For many, the predictable pattern of moon phases is just a mysterious and beautiful part of our night sky. In fact, understanding why we see the Moon as we do requires some fairly challenging spatial reasoning. Amplify Science California helps students gain a deeper understanding of everyday observations of the Moon, transforming the experience of Moon gazing into an act of profound and expansive perception.

> Unlike a typical curriculum, Amplify Science California anchors learning by inviting students to take on the role of scientists and engineers.

In this unit, students take on the role of astronomers. Their job is to advise an astrophotographer who needs to take photographs of the Moon for a fictional magazine called *About Space.* The astrophotographer can only take pictures of specific features on the Moon at certain times. Working together, they figure out where the Moon's light comes from, what causes the characteristic changes in the appearance of the Moon that we observe, and what conditions are required to view phenomena, such as particular moon phases and lunar eclipses. The unit concludes with a Science Seminar, in which students use what they have learned to determine if Kepler-47c, a planet that orbits around a pair of binary stars, will ever experience a lunar eclipse of its moon.

Unit Type: Core

Student Role: Astronomers

Phenomenon: Pictures of specific features on the Moon can only be taken by an astrophotographer at certain times.

Core Concept: Understanding why the Moon's appearance changes as it orbits Earth

Target Performance Expectations:

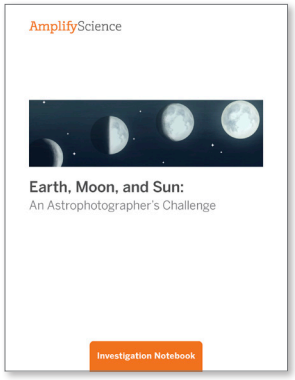
- ESS1-1: Earth, Sun, Moon Systems
- ESS1-2: Gravity
- ESS1-3: Scale in the Solar System

Related Performance Expectations:

- PS2-4: Gravity Depends on Mass

Students figure out the unit phenomenon through the use of a variety of resources.

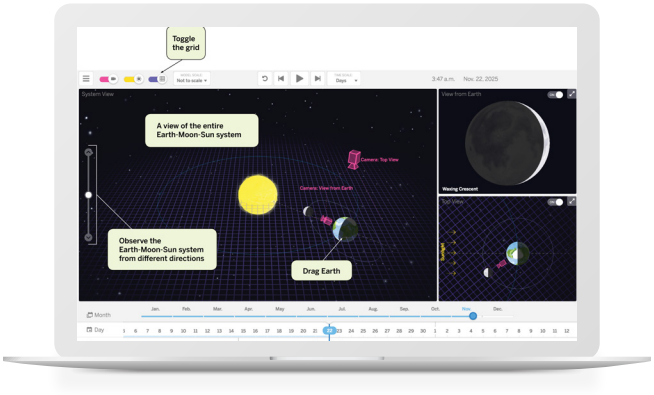
Student Investigation Notebook



Hands-On Kit

Videos

Digital Tools



About technology in this unit:
All Amplify Science California lessons were designed with device sharing in mind, and never assume that every student has a separate device.

In this grade, student-facing technology includes Practice Tools and digital Simulations. When the use of a digital tool is called for in a lesson, teachers have several implementation options:

If limited student devices are available—teachers can have students do activities in pairs or small groups.

If no student devices are available—teachers can project the digital tool to the class and either "drive" the digital tool themself or invite students to "drive" by using their device.

If internet access is unavailable—teachers can "pre-load" the digital tool on their device for use offline.

Chapter 1: The storyline begins

What students investigate:

Why is there a border between light and dark on the Moon?

What students figure out:

The Moon does not make its own light, but rather the sun illuminates the Moon. In addition, the sun only illuminates the half of the Moon that is facing it, leaving the other half of the Moon dark. This is because light from the sun travels in straight lines. When it comes to models, a model is to scale when object sizes and distances are larger or smaller than in the real world, but the same relative to one another.

How they figure it out:

- Analyzing photographs of the Moon
- Testing the effect of turning sunlight on and off in the Sim
- Observing a physical model using a lightbulb to represent the sun and a foam sphere to represent the Moon
- Using the Modeling Tool to demonstrate their understanding

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


READING


SIM


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Picturing the Moon

- Warm-Up (5 min)
- Video: Photographing the Moon (5 min)
- Taking Pictures of the Moon (15 min)
- Investigating Light on the Moon (20 min)
- Homework
- Family Homework Experience

On-the-Fly Assessment

DAY 3 | LESSON 1.3

Modeling Light and Dark on the Moon

- Warm-Up (5 min)
- Debriefing the Warm-Up (15 min)
- Introducing the Moon Sphere Model (5 min)
- The Moon Sphere Model: Light and Dark (20 min)
- Homework

On-the-Fly Assessment

DAY 4 | LESSON 1.4

Simulating Light and Dark on the Moon

- Warm-Up (5 min)
- Investigating Darkness on the Moon (15 min)
- Modeling Light and Dark (20 min)
- Taking Pictures of the Moon (5 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
End-of-Chapter Modeling Self-Assessment

Chapter 2: The storyline builds

What students investigate:

Why does the border between light and dark on the Moon change location?

What they figure out:

From Earth we can only see the half of the Moon that is facing us. Because the Moon moves to different positions around Earth, we see different amounts of the illuminated half of the Moon. This is why we see different phases of the Moon. There is a pattern to the appearance of the Moon because the Moon orbits around Earth. It takes about one month for the Moon to orbit Earth, so it takes about one month to see the full pattern of moon phases. This pattern repeats with every orbit of the Moon.

How they figure it out:

- Reading about moon phases in the article *Phases of the Moon*
- Examining how the Moon appears in different positions relative to the Earth and sun using the physical model from the previous chapter
- Watching a video about how the point of view from which the Moon is viewed affects how it appears
- Making predictions about how the appearance of the Moon changes, and checking those predictions using the Sim and a paper model
- Writing and using the Modeling Tool to demonstrate their understanding

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WARM-UP


WRITING

DAY 5 | LESSON 2.1

"Phases of the Moon"

- Warm-Up (5 min)
- Reading "Phases of the Moon" (30 min)
- Discussing Annotations (10 min)

On-the-Fly Assessment

DAY 6 | LESSON 2.2

Gathering Evidence About Moon Phases

- Warm-Up (5 min)
- Gathering Evidence from a Model (20 min)
- Gathering Evidence from a Text (15 min)
- Choosing a Claim (5 min)
- Homework

On-the-Fly Assessment

DAY 7 | LESSON 2.3

Simulating Moon Phases

- Warm-Up (5 min)
- Modeling Moon Phases (10 min)
- Video: Seeing the Earth, Moon, and Sun from Different Angles (5 min)
- Why We See Phases of the Moon (20 min)
- Revising Moon Phase Models (5 min)

On-the-Fly Assessment

DAY 8 | LESSON 2.4

Moon Phase Patterns

- Warm-Up (5 min)
- The Moon Sphere Model: Phase and Orbit (15 min)
- Write and Share: Discussing Moon Phases (20 min)
- Modeling the Order of Moon Phases (5 min)
- Homework

On-the-Fly Assessment

DAY 9 | LESSON 2.5

Orbit and the Pattern of Moon Phases

- Warm-Up (5 min)
- Modeling Moon Phases on Paper (25 min)
- Taking Pictures of the Moon (10 min)
- Introducing the Homework (5 min)
- Homework

On-the-Fly Assessment
End-of-Chapter Modeling

DAY 10 | LESSON 2.6

Critical Juncture Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

Critical Juncture Assessment

DAY 11 | LESSON 2.7

Taking on New Challenges

- Warm-Up (5 min)
- Preparing for the Sim Activities (5 min)
- Sim Activity (30 min)
- Sharing Results (5 min)
- Self-Assessment (Optional)

Self-Assessment

Chapter 3:
The storyline gets more complex

What students investigate:

What are the conditions that cause a lunar eclipse?

What they figure out:

During a lunar eclipse, the Moon is completely dark because Earth blocks sunlight from hitting the Moon. Lunar eclipses can only happen when Earth is directly in between the sun and the Moon. Lunar eclipses do not happen every time Earth is in between the sun and the Moon. The Moon is only completely dark when the sun, Earth, and the Moon are in a straight line, with Earth in the middle.

How they figure it out:

- Exploring lunar eclipses using the Sim and the physical model
- Reading about an ancient device found in a shipwreck that was used to predict lunar eclipses in the article *An Ancient Machine for Predicting Eclipses*
- Creating visual models of a lunar eclipse using the Modeling Tool
- Explaining the cause of a lunar eclipse in their writing use the Reasoning Tool

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WARM-UP


WRITING

DAY 12 | LESSON 3.1

Introduction to Lunar Eclipses

- Warm-Up (5 min)
- The Moon Sphere Model: Lunar Eclipses (15 min)
- Exploring Lunar Eclipses (20 min)
- Introducing System View in the Modeling Tool (5 min)
- Homework

On-the-Fly Assessment

DAY 13 | LESSON 3.2

Reading About Predicting Eclipses

- Warm-Up (5 min)
- Reading: "An Ancient Machine for Predicting Eclipses" (25 min)
- Discussing Annotations (10 min)
- Explaining the homework (5 min)
- Homework

On-the-Fly Assessment

DAY 14 | LESSON 3.3

Gathering Evidence About Lunar Eclipses

- Warm-Up (5 min)
- Gathering Evidence from the Sim (15 min)
- Gathering Evidence from a Text (15 min)
- Modeling a Lunar Eclipse and a Full Moon (10 min)
- Homework

On-the-Fly Assessment
End-of-Chapter Modeling

DAY 15 | LESSON 3.4

When and Why We See Lunar Eclipses

- Warm-Up (5 min)
- Discussing Lunar Eclipses (15 min)
- Reasoning About Photographing an Eclipse (20 min)
- Introducing the Homework (5 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 4:
Application to a new storyline

What students investigate:

Kepler-47c is a planet that orbits around a pair of binary stars. It will be featured in the *About Science* magazine. The artist illustrating Kepler-47c for the article wants to show the moon of Kepler-47c during a lunar eclipse, but she is uncertain about whether a lunar eclipse is likely to happen to a moon of a planet that orbits around two stars. So the question is: Will there be a lunar eclipse of the moon of Kepler-47c?

What they figure out:

Scientists must communicate how their claims and evidence are supported with reasoning in a convincing scientific argument. A written scientific argument needs to state a claim, describe specific evidence, and explain how the evidence supports the claim to convince its reader. A claim can sometimes be supported more effectively if you consider the combination of several different pieces of evidence.

How they figure it out:

- Creating drawings that compare and contrast the Earth, Moon, and sun systems with a new two-star system
- Reviewing available evidence to make an argument
- Engaging in oral argumentation in a student-led discourse routine called a Science Seminar
- Writing final arguments

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WARM-UP


WRITING

DAY 16 | LESSON 4.1

Lunar Eclipses Outside Our Solar System

- Warm-Up (5 min)
- Introducing Kepler-47c (5 min)
- Analyzing Evidence (25 min)
- Sorting Evidence (10 min)
- Homework

DAY 17 | LESSON 4.2

Discussing Eclipses in a Two-Star System

- Warm-Up (5 min)
- Preparing for the Science Seminar (15 min)
- Introducing the Science Seminar (5 min)
- Participating in the Science Seminar (20 min)
- Homework

DAY 18 | LESSON 4.3

Writing a Scientific Argument

- Warm-Up (5 min)
- Using the Reasoning Tool (15 min)
- Organizing Ideas in the Reasoning Tool (10 min)
- Writing Scientific Arguments (15 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Science Seminar Argument
Self-Assessment

DAY 19 | LESSON 4.4

End-of-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written Response Question #1 (10 min)
- Written Response Question #2 (10 min)

End-of-Unit Assessment

All students. All standards.

Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science California to allow for truly in-depth and integrated coverage of the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Unlike other programs, however, ours makes the NGSS' vision of "all students, all standards" a reality by creating a unit-specific learning progression for every unit called a Progress Build.

Each Progress Build defines several levels of understanding of the unit's anchoring phenomenon, with each level integrating and building upon the knowledge and skills from lower levels. In this way, each Progress Build provides a clear roadmap for how students' understanding of the phenomenon is expected to deepen and develop with each successive chapter and lesson.

What's more, the program's system of assessments is also tied to these Progress Builds. This carefully crafted integration provides teachers with credible, actionable, and timely diagnostic information about student progress toward the unit's learning goals and grade-level performance expectations. Armed with this powerful data, teachers have the ultimate flexibility to decide when to move on and when to slow down and dive deeper.

Earth, Moon, and Sun Progress Build

The Progress Build in this unit consists of three levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding of why the Moon's appearance changes as it orbits Earth.

Progress Build Level 1:

We see the Moon because the sun illuminates the half of the Moon that is facing it.

Progress Build Level 2:

The Moon's repeating cycle of phases is caused by the Moon's changing position in its orbit around Earth.

Progress Build Level 3:

Lunar eclipses happen during relatively rare moments when the sun, Earth, and the Moon are perfectly aligned.

Examples of differentiation in this unit

In addition to providing unit-specific Progress Builds that break learning goals into smaller, more achievable levels of understanding, Amplify Science California makes learning accessible for all students through a variety of scaffolds, supports, and differentiation strategies for every lesson. **For a complete list of strategies, see the Differentiation section of every Lesson Brief**.

Below are a few examples of strategies embedded in this unit.

For English learners:

Promoting inclusion in discussions. (Example from Lesson 1.3)
Providing some English learners with one-on-one teacher discussion time may help them share their ideas in a low-stakes environment. In this lesson, English learners will be more likely to participate in the whole class discussions if you can check in with them right before the guided exploration and whole group discussion. Begin some of the guided exploration with them one-on-one and ask them some of the questions that will be part of the discussion. Encourage them to share their thinking with you by letting them know when what they have said is accurate and restating their ideas back to them using academic language if necessary. Help these students decide which question (if any) they feel comfortable answering in the group discussion and rehearse with them, allowing them to write their answer down if they would like. This type of pre-discussion will ensure that they have ideas they are confident sharing with the class. Even if these students decide they would rather not share in the whole group discussion, you will still have had the opportunity to hear their ideas.

For students needing more support:

Additional visuals and modalities (Example from Lesson 2.4)
Students who need more support may benefit from diagramming the moon phases on paper. Provide paper for students who learn by drawing and stop them every so often to draw and label a view of the Moon sphere. Many students benefit from processing new information in different modalities, so asking them to reconstruct each of these ideas in a new and novel way can help students to better understand the important ideas that are the focus of this lesson.

For students ready for a challenge:

Planning independent Sim investigations (Example from Lesson 3.3)
In addition to the lunar eclipses discussed throughout this chapter, students can also observe solar eclipses in the Sim. Students who need more challenge can be directed to investigate solar eclipses by using the Sim to compare and contrast them with lunar eclipses.

3-D Statements

In order to help teachers recognize the three-dimensional structure of every unit, chapter, and lesson, each unit contains a 3-D Statement document that makes the integration clear.

Making the 3-D statement document all the more effective, the three dimensions are color-coded for easy recognition.

Earth, Moon, and Sun 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students use digital and physical models to investigate the Earth-Moon-sun system (systems and system models) in order to construct explanations of how the motion of Earth around the sun and the Moon around Earth cause lunar eclipses and the cyclic pattern of moon phases (patterns).

Chapter Level

Chapter 1: Light and Dark on the Moon

Students use physical and digital models of the Earth-Moon-sun system (systems and system models) to gather evidence and construct explanations of why half of the Moon is always dark. They also explore the concept of scale in models (scale, proportion, and quantity).

Chapter 2: Moon Phases

Students analyze and interpret evidence from a variety of sources—including a physical model, a digital model, and an article—to investigate the relationship between the Moon's orbital motion and the monthly pattern of Moon phases (patterns). Students use what they figure out to collaboratively construct visual models that depict this pattern.

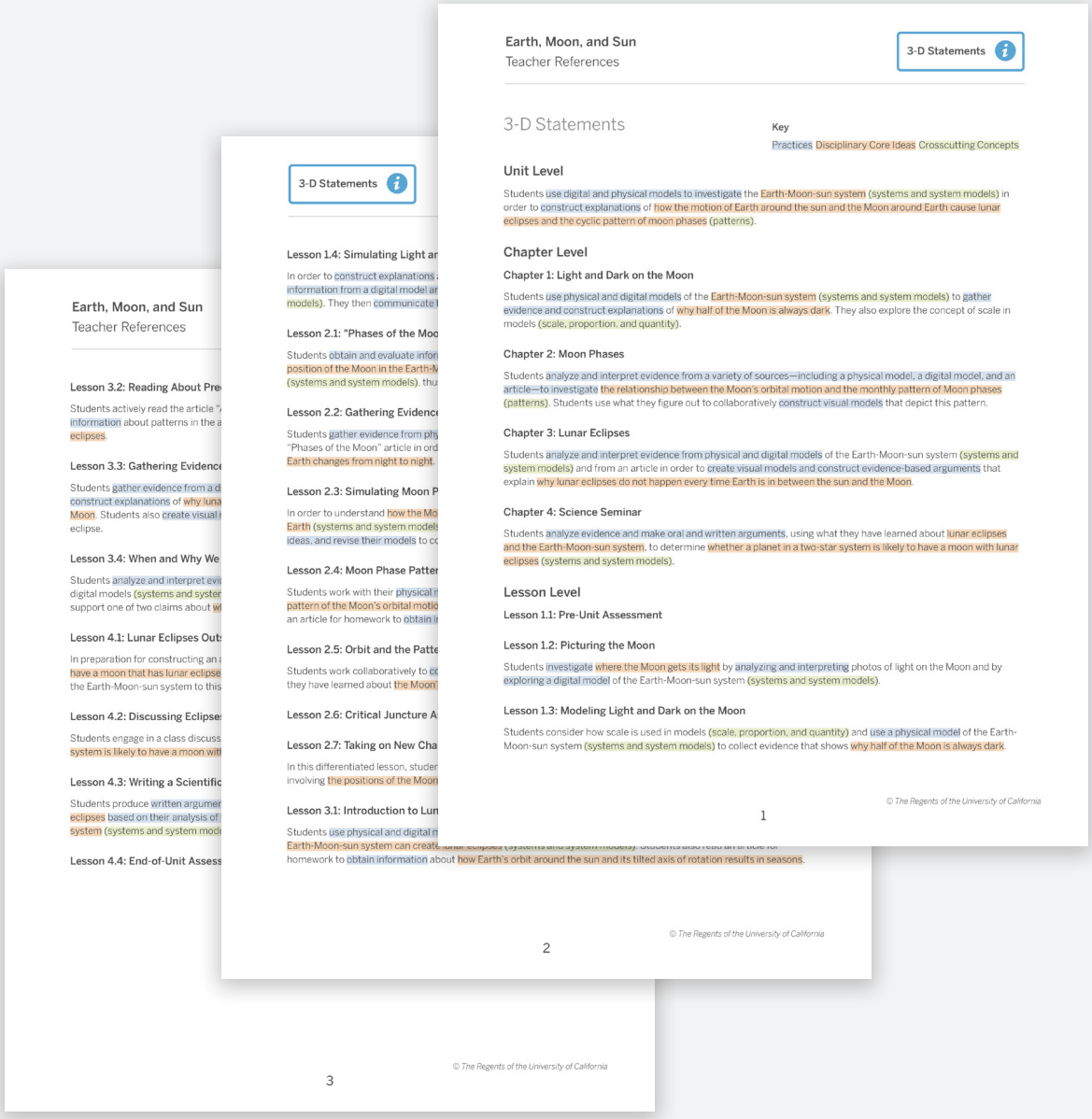
Chapter 3: Lunar Eclipses

Students analyze and interpret evidence from physical and digital models of the Earth-Moon-sun system (systems and system models) and from an article in order to create visual models and construct evidence-based arguments that explain why lunar eclipses do not happen every time Earth is in between the sun and the Moon.

Chapter 4: Science Seminar

Students analyze evidence and make oral and written arguments, using what they have learned about lunar eclipses and the Earth-Moon-sun system, to determine whether a planet in a two-star system is likely to have a moon with lunar eclipses (systems and system models).

To review the 3-D Statements at the lesson level, see the Lesson Brief section of every lesson.



Notes

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For more information on Amplify Science, visit **amplify.com/science/california**.

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