



Earth, Moon, and Sun:

An Astrophotographer's Challenge



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Safety Guidelines for Science Investigations

1. **Follow instructions.** Listen carefully to your teacher's instructions. Ask questions if you don't know what to do.
2. **Don't taste things.** No tasting anything or putting it near your mouth unless your teacher says it is safe to do so.
3. **Smell substances like a chemist.** When you smell a substance, don't put your nose near it. Instead, gently move the air from above the substance to your nose. This is how chemists smell substances.
4. **Protect your eyes.** Wear safety goggles if something wet could splash into your eyes, if powder or dust might get in your eyes, or if something sharp could fly into your eyes.
5. **Protect your hands.** Wear gloves if you are working with materials or chemicals that could irritate your skin.
6. **Keep your hands away from your face.** Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
7. **Tell your teacher if you have allergies.** This will keep you safe and comfortable during science class.
8. **Be calm and careful.** Move carefully and slowly around the classroom. Save your outdoor behavior for recess.
9. **Report all spills, accidents, and injuries to your teacher.** Tell your teacher if something spills, if there is an accident, or if someone gets injured.
10. **Avoid anything that could cause a burn.** Allow your teacher to work with hot water or hot equipment.
11. **Wash your hands after class.** Make sure to wash your hands thoroughly with soap and water after handling plants, animals, or science materials.

Name: _____

Date: _____

Earth, Moon, and Sun: An Astrophotographer's Challenge

Unit Overview

Have you ever looked at the Moon and wondered why it looks different from night to night? In this unit, you will explore why the Moon's appearance looks the way it does and why it changes. In the role of student astronomer, you will advise Eric Wu, an astrophotographer capturing surface features of the Moon for *About Space* magazine. Through hands-on investigations, Sim missions, and by reading and talking to your peers, you will come to an understanding of the way the Moon moves and why it appears the way it does from Earth.

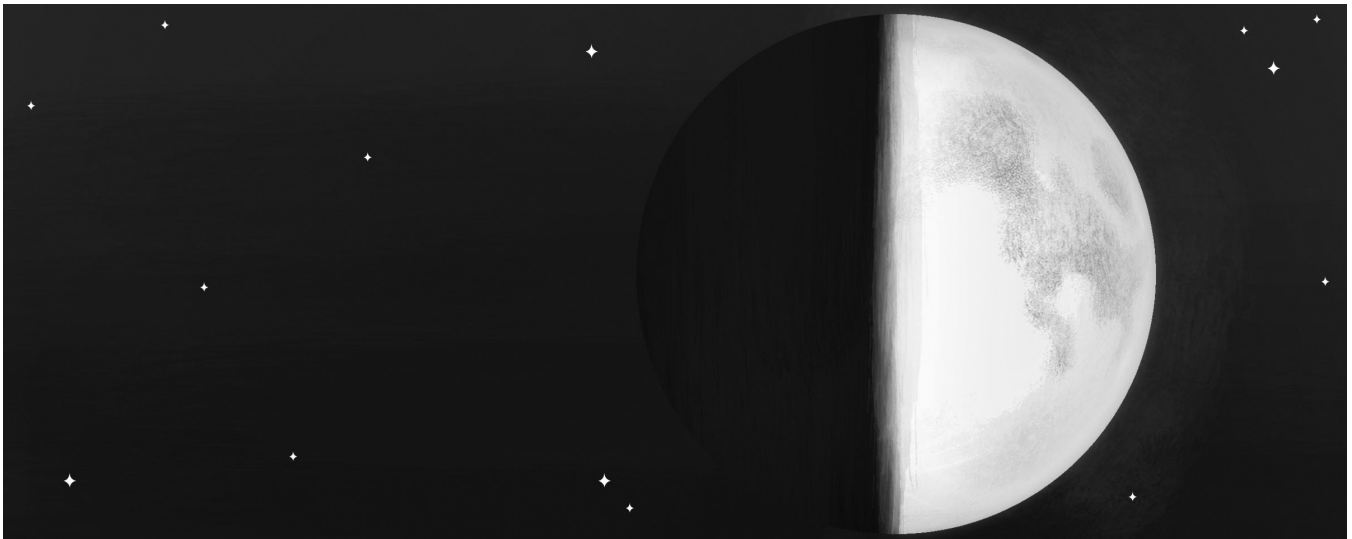
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Date: _____

Chapter 1: Light and Dark on the Moon

Chapter Overview

In order to take the best pictures of the Moon that he can for *About Space* magazine, Eric Wu needs the light and dark parts of the Moon to look a certain way. To help him find the right time to take these photos, you'll begin by investigating why there is a border between light and dark on the Moon.



Lesson 1.2: Picturing the Moon

Welcome to your new unit on Earth, the Moon, and the sun! You are about to take on the role of a student astronomer. Today, you will meet Eric Wu, an astrophotographer trying to take photos of the Moon for *About Space* magazine. Eric is great at taking photos, but he doesn't know much about the Moon. In order to take the best pictures possible, Eric needs the light on the Moon to look a certain way, and he needs you to help him figure out when and why that will happen. You'll begin by using a digital simulation to study light on the Moon. Student astronomers, don't let Eric get left in the dark!

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 1 Question

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

Vocabulary

- illuminate
- moon
- sun

Digital Tools

- *Earth, Moon, and Sun* Simulation

Name: _____

Date: _____

Warm-Up

Thinking About the Moon

Look at these images and think about what you know about the Moon. Then, record your thoughts in the space below.



What do you already know about the Moon?

Name: _____

Date: _____

Investigating Light on the Moon

Part 1: Introducing the *Earth, Moon, and Sun* Simulation

Talk with your partner as you explore the *Earth, Moon, and Sun* Simulation. Share what you both notice.

As you explore the Sim, discuss the following questions with your partner:

- How many different views are there in the Sim?
- What do the different buttons do in the Sim?
- What did you notice about what you can change in the Sim?
- What questions do you have about the Sim?

Part 2: Using the Sim to Investigate Light on the Moon

Goal: Look for evidence in the Simulation to answer the Investigation Question: *Where does the Moon get its light?*

Tips:

- You may find it helpful to close some views and observe one view at a time.
- You may want to try turning sunlight on and off.

Where does the Moon get its light? (check one)

- The Moon makes its own light.
- The Moon gets light from the sun.
- The Moon gets light from Earth.

What evidence from the Sim helped you answer the Investigation Question?

Name: _____

Date: _____

Homework: Reading “The Solar System Is Huge”

Read the “The Solar System Is Huge” article. Annotate anything in the article that helps you understand why it is difficult to make models of objects in the solar system. When you are finished reading, use your annotations to answer the question.

Why is it difficult to make models of objects in the solar system?

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Lesson 1.3: Modeling Light and Dark on the Moon

Eric Wu needs to take pictures at the border between the light and the dark part of the Moon. But, if the sun is so much larger than the Moon and it is what lights up the Moon, then why is part of the Moon dark at all? In this lesson, you will set up a physical model of the Earth, Moon, and sun system to gather evidence about why part of the Moon is dark.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 1 Question

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

Key Concepts

- The Moon does not make its own light; the sun illuminates the Moon.

Vocabulary

- illuminate
- model
- moon
- scale
- sun

Digital Tools

- Scale Tool

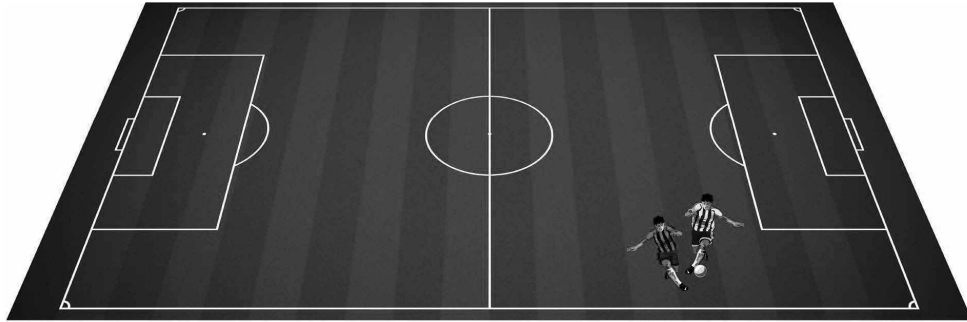
Name: _____

Date: _____

Warm-Up

How useful is the model?

Model 1: to scale



Model 2: not to scale



In which model can you see the ball most clearly? (check one)

Model 1

Model 2

Which model is more accurate? (check one)

Model 1

Model 2

Which of the two models do you think is most useful? (check one)

Model 1

Model 2

Name: _____

Date: _____

Thinking About Scale in the Moon Sphere Model

Discuss these questions with your group.

1. Do you think that the lightbulb and the Moon spheres are “to scale” compared to the real sizes of the sun and the Moon?
2. If a student holds the Moon sphere out in front of her at arm’s length, will the distance between the Moon sphere and her head be “to scale”?
3. Why is it sometimes necessary to use a model that is “not to scale”?

Name: _____

Date: _____

Homework: Reading “The Dark Side of the Moon”

Read the “The Dark Side of the Moon” article. Annotate anything in the article that helps you understand why part of the Moon is dark. When you are finished reading, use your annotations to answer the question.

Why is part of the Moon dark?

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Lesson 1.4: Simulating Light and Dark on the Moon

If the sun illuminates the Moon, then why is part of the Moon dark? Today, you'll use the Sim to answer this question and explain why there is a border between light and dark on the Moon. If you're going to help Eric Wu get the pictures he needs for *About Space* magazine, then there's no time to waste! Good luck, student astronomers.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 1 Question

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

Key Concepts

- The Moon does not make its own light; the sun illuminates the Moon.
- When a model is "to scale," object sizes and distances are larger or smaller than in the real world but the same relative to one another. Some models need to be "not to scale" to be useful.
- The sun illuminates the half of the Moon that is facing it, and the other half is dark.
- Light from the sun travels in straight lines.

Vocabulary

- illuminate
- model
- moon
- sun

Digital Tools

- *Earth, Moon, and Sun* Modeling Tool activity: Light and Dark
- *Earth, Moon, and Sun* Simulation

Name: _____

Date: _____

Warm-Up

Light and Dark on the Moon

Think about the experiences you have had during this chapter as you answer the Chapter 1 Question below. You will get a chance to revise your answer later in this lesson.



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

Name: _____

Date: _____

Investigating Darkness on the Moon

Investigation Question: *Why is part of the Moon dark?*

Launch the *Earth, Moon, and Sun* Simulation, make observations to help answer the Investigation Question, and follow the instructions below.

Use the space below to record your observations from the Sim that help you answer the Investigation Question. Feel free to draw in the space.

My Observations

Why is part of the Moon dark? (check one)

- Light from the sun only illuminates half of the Moon.
- Earth's shadow is on half of the Moon.
- The Moon only makes light on one side.
- Clouds are blocking half of the Moon's light.
- The Moon is made up of light and dark rocks.

Explain how your observations help you answer the Investigation Question.

Name: _____

Date: _____

Modeling Light and Dark

Launch the *Earth, Moon, and Sun Modeling Tool* activity: Light and Dark.

Goal: Show light and dark on the Moon.

Do:

- Press the pencil to edit the light in the Top View panel.
- Drag a light shape onto the Moon. Then, rotate the light shape.

Tips:

- The position of the Moon cannot be edited.
- You can add a light shape to Earth, but you do not need to.

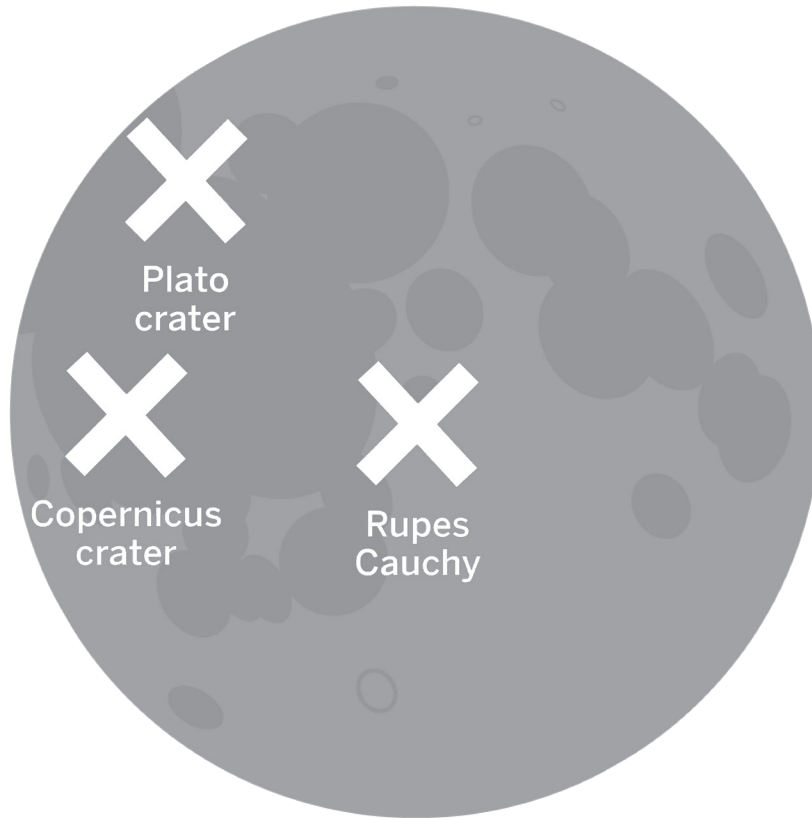
When your model is complete, press HAND IN. Write your partner's name here if you had one:

Use your model to help you revise or add to your answer to the Chapter 1 Question: *Why is there a border between light and dark on the Moon?*

Taking Pictures of the Moon

Look back at the question and the claims about when Eric Wu can take pictures of the three Moon features for *About Space* magazine. With your partner, discuss which claim seems better, based on what you know so far. When you are finished talking, select the claim you think is best below.

Question: When can Eric Wu take pictures of the three Moon features?



Based on what you know so far, which claim do you think is best? (check one)

- Claim 1:** Photographs of these features can be taken on any night.
- Claim 2:** Photographs of these features can only be taken on some nights.

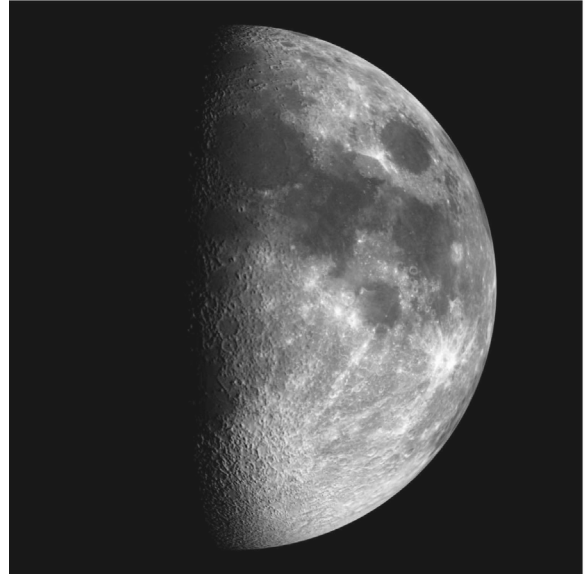
Homework: Looking Closer at the Moon

As Eric Wu was preparing for his assignment, he found some photos of the Moon that he took a few years ago. He thought that you might be able to use them to help him figure out when he should take the photos for *About Space* magazine. Look at these images and record what you notice. Then, answer the question below.

Image 1



Image 2



What do you notice about these two images?

Why do you think the Moon looks different in these two images? (check one)

- Because light from the sun is traveling from the **left** in Image 1 and traveling from the **right** in Image 2.
- Because light from the sun is traveling from the **right** in Image 1 and traveling from the **left** in Image 2.
- Because light from the sun is traveling in a **straight line** in Image 1, but it is **curving around** in Image 2.
- Because light from the sun is traveling in a **straight line** in Image 2, but it is **curving around** in Image 1.

Name: _____

Date: _____

Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

Scientists investigate in order to figure things out. You have been investigating what determines the appearance of the Moon from Earth, in order to tell astrophotographer Eric Wu when he can take photographs. Are you getting closer to understanding what determines the Moon's appearance?

1. I understand where the Moon gets its light. (check one)

yes

not yet

Explain your answer choice.

2. I understand why we see different phases of the Moon. (check one)

yes

not yet

Explain your answer choice.

3. I understand what causes the pattern of the Moon's phases. (check one)

yes

not yet

Explain your answer choice.

Name: _____ Date: _____

Homework: Check Your Understanding (continued)

4. I understand what happens during a lunar eclipse. (check one)

yes

not yet

Explain your answer choice.

5. I understand why lunar eclipses happen. (check one)

yes

not yet

6. What do you still wonder about what determines the Moon's appearance from Earth?

Chapter 2: Moon Phases

Chapter Overview

Even though the sun consistently illuminates half of the Moon, when we look up at the Moon from Earth, it looks very different from night to night. Why does this happen? Will it affect when Eric Wu can take his photographs? Investigating why the appearance of the Moon changes is the next step in helping Eric complete his assignment for *About Space* magazine.



Lesson 2.1: “Phases of the Moon”

Okay, student astronomers, you’ve learned that light from the sun only illuminates half of the Moon, which explains the presence of the terminator, the border between light and dark on the Moon. So why does the Moon look so different from night to night? Some nights, we can see the terminator clearly, and on other nights, it looks like it isn’t there at all! If Eric Wu is going to get the pictures he needs for *About Space* magazine, he’s going to need you to help him figure out when and why the appearance of the Moon changes. Today, you’ll take the next step by reading an article about the many phases of the Moon.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 2 Question

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

Vocabulary

- illuminate
- moon
- moon phase
- orbit
- sun

Name: _____

Date: _____

Warm-Up

Comparing Photos of the Moon

Eric Wu found a third photo of the Moon that he took a few years ago and sent it to you along with a question. Look at the third image and compare it to the two images Eric already sent you. Then, respond to his question.



Eric said, “I took these photos from the same hill behind my house on three different nights. If half of the Moon is always illuminated and the other half is always dark, then why does the Moon look so different on different nights?”

Name: _____

Date: _____

Reading “Phases of the Moon”

1. Read and annotate the article “Phases of the Moon.”
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

What is something about the text that you discussed with your partner?

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Lesson 2.2: Gathering Evidence About Moon Phases

Student astronomers, you've learned that people have many different ideas about the Moon. As scientists, however, you need to have evidence in order to support a claim. Today, you're going to investigate two claims about why the appearance of the Moon changes. In order to decide which claim is stronger, you'll need evidence from two familiar sources: the Moon Sphere Model and the "Phases of the Moon" article. Which claim will the evidence support? It's time to find out!

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 2 Question

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

Vocabulary

- illuminate
- model
- moon
- moon phase
- sun

Warm-Up

Seeing the Moon in a New Light

Look closely at this image. Then, answer the questions below.



In this photo, what is similar about the appearance of the Moon and the appearance of the stone sphere on the top of the post?

Why do you think the appearance of the Moon and the stone sphere is similar in this way?

Hint: Think about the light in the image.

Name: _____

Date: _____

Gathering Evidence from a Model

Try to model as many of the five moon phases as you can, using your Moon sphere. As you use your Moon sphere, think about how your model can act as evidence that supports Claim 1 or Claim 2. Discuss this evidence with your partner and record it in the spaces below.

You may not be able to find evidence to support both claims.

Investigation Question: *If half of the Moon is always illuminated, why does its appearance from Earth change?*

Claim 1: The Moon's appearance changes because Earth casts a shadow on the Moon.

Claim 2: The Moon's appearance changes because the position of the Moon changes.



Record your evidence about the Moon's appearance changing because Earth casts a shadow on the Moon.

Record your evidence about the Moon's appearance changing because the position of the Moon changes.

Name: _____

Date: _____

Gathering Evidence from a Text

Reread the sections titled “New Moon,” “Crescent Moon,” and “Quarter Moon” from “Phases of the Moon.” As you read, highlight or make note of any evidence in the article that supports Claim 1 or Claim 2. Discuss this evidence with your partner and record it in the spaces below.

You may not be able to find evidence to support both claims in the article.

Investigation Question: *If half of the Moon is always illuminated, why does its appearance from Earth change?*

Claim 1: The Moon’s appearance changes because Earth casts a shadow on the Moon.

Claim 2: The Moon’s appearance changes because the position of the Moon changes.

Record your evidence about the Moon’s appearance changing because Earth casts a shadow on the Moon.

Record your evidence about the Moon’s appearance changing because the position of the Moon changes.

Name: _____

Date: _____

Choosing a Claim

Discuss with your partner which claim you think is best supported by the evidence you gathered during this lesson. Then, choose the claim that you think is best and explain how your evidence supports this claim.

Investigation Question: *If half of the Moon is always illuminated, why does its appearance from Earth change?* (check one)

Claim 1: The Moon's appearance changes because Earth casts a shadow on the Moon.

Claim 2: The Moon's appearance changes because the position of the Moon changes.

Explain in writing how the evidence supports your claim.

Name: _____

Date: _____

Homework: Reading “Meet a Scientist Who Studies the Early Solar System”

In today’s lesson, you used evidence to figure out why the Moon’s appearance from Earth changes. To learn about a scientist who uses evidence to figure out how the Moon came to be, read and annotate the “Meet a Scientist Who Studies the Early Solar System” article. Then, answer the questions below.

What kinds of evidence are scientists using to learn about how the Moon came to be?

What excites Kaveh Pahlevan about his work?

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Lesson 2.3: Simulating Moon Phases

In order to advise Eric Wu about when he can photograph surface features on the Moon, you need to understand when the terminator will be near those features. You know that the terminator is in different places, depending on the phase of the Moon. Now you will use the Modeling Tool and the Sim to better understand how moon phase and moon position are related. What you learn today will come in handy later, when the time comes to advise Eric.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 2 Question

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

Vocabulary

- illuminate
- model
- moon
- moon phase
- scale
- sun

Digital Tools

- *Earth, Moon, and Sun* Modeling Tool activity: Predict Moon Phase
- *Earth, Moon, and Sun* Simulation

Name: _____

Date: _____

Warm-Up

Exploring New Modeling Tool Features

- Launch the *Earth, Moon, and Sun* Modeling Tool activity: Predict Moon Phase.
- Observe and explore any new features in the Predict Moon Phase activity.

What do you observe that is new and different?

What questions do you have?

Name: _____

Date: _____

Modeling Moon Phases

Launch *Earth, Moon, and Sun Modeling Tool* activity: Predict Moon Phase. You will make a model now and have a chance to revise it at the end of this lesson.

When your model is complete, press HAND IN. Write your partner's name here if you had one:

Goal: Show how the Moon is illuminated at different times.

Do:

- Tap the pencils to edit the Moon's light in the Top View and View from Earth panels.
- Add and rotate light shapes in the Top View panels.
- Add and rotate a light shape in each View from Earth panel, based on the Moon's position in the Top View panel above it.

Tips:

- In the Top View panels, the Moon is shown in three positions that cannot be edited.
- Need help? Turn on the Guide.
- You can add a light shape to Earth, but you do not need to.

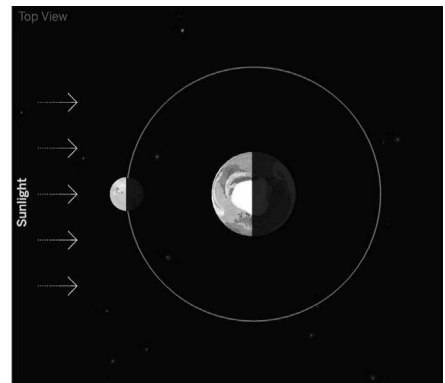
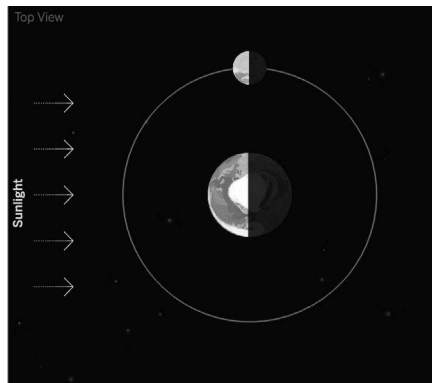
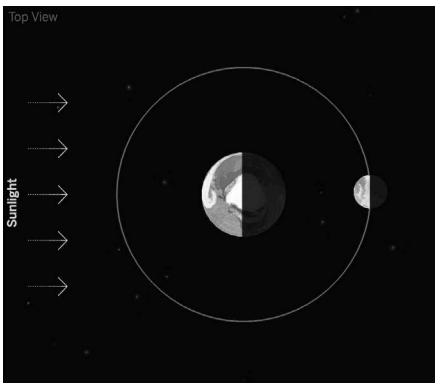
Turn the page to complete the Sim mission, and then return to the Modeling Tool activity to make any revisions from the evidence you gathered in the Sim.

Why We See Phases of the Moon

Part 1

Launch the *Earth, Moon, and Sun* Simulation. In Top View, move the Moon to each of the positions shown below. Then, observe the Moon in View from Earth.

Using the words *all*, *half*, and *none*, record your observations by labeling each of the Top View images below. How much of the illuminated part of the Moon is visible from Earth?



Part 2

Launch the *Earth, Moon, and Sun* Simulation.

1. Form partners and choose who will be Partner A and B.
2. **Partner A:** Hide the device from your partner, move the Moon in Top View, observe how much of the Moon is illuminated in View from Earth, and then turn off View from Earth. Show the Sim to your partner, and ask your partner to predict the View from Earth. Then, turn on View from Earth to check that prediction.
3. **Both partners:** Discuss how the position of the Moon around Earth in Top View changes the appearance of the Moon in View from Earth.
4. **Partner B:** Repeat steps 2 and 3 above by quizzing Partner A and discussing.
5. **Both partners:** Try reversing the activity once by turning off Top View and asking your partner to predict the Top View based on the View from Earth.
6. **Both partners:** Continue to take turns quizzing each other and discussing how Top View and View from Earth are related.

Lesson 2.4: Moon Phase Patterns

To take photographs of the three Moon features for *About Space* magazine, Eric Wu needs to know in advance where the terminator will be. But how can Eric possibly know that? He can't predict the future! Fortunately, you and your fellow student astronomers are here to help. Today, you will work with the Moon Sphere Model to better understand how the Moon's orbit creates each moon phase, and soon you'll be able to predict the Moon's changing appearance from day to day.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 2 Question

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

Key Concepts

- 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.

Vocabulary

- | | |
|--------------|-----------|
| • illuminate | • orbit |
| • model | • pattern |
| • moon | • scale |
| • moon phase | • sun |

Digital Tools

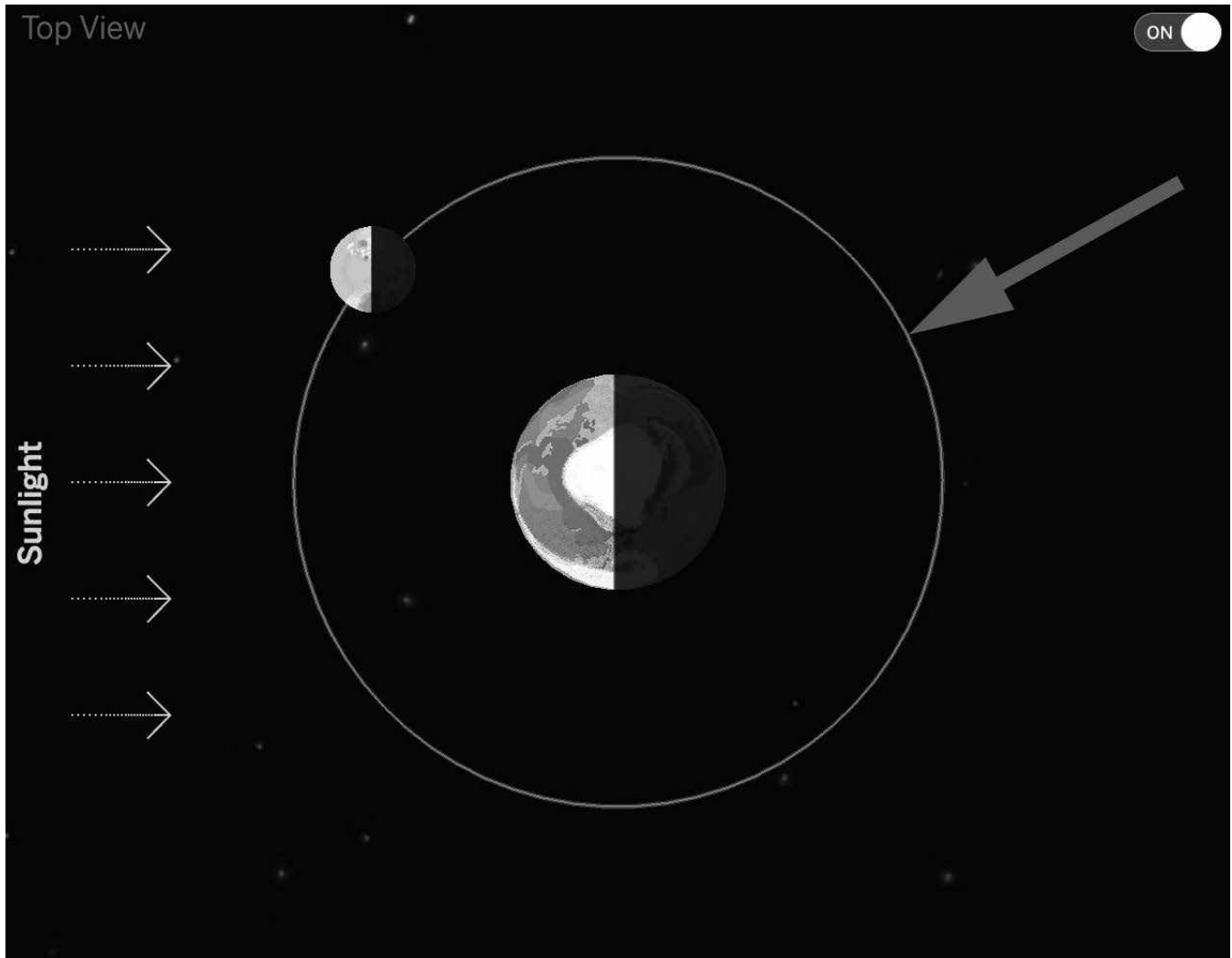
- *Earth, Moon, and Sun* Modeling Tool activity: Order and Match Views

Name: _____

Date: _____

Warm-Up

Consider the image from the Sim below, and then answer the question.



In this image of Earth and the Moon from the Sim, what does the circle around Earth represent?

Name: _____

Date: _____

The Moon Sphere Model: Phase and Orbit

Observe the Phases of the Moon

- Face the lamp, holding the Moon sphere at arm's length a little above your head.
- Observe new moon phase.
- Turn your body slightly to the left, away from the lamp (sun).
- Observe crescent moon phase.
- Continue turning to observe quarter, gibbous, and full moon phases.
- Continue turning until you observe a new moon phase again.

Work in pairs to observe Top View and View from Earth

- **Top View observer:** Watch from above while your partner moves the Moon sphere in its orbit.
- **View from Earth observer:** Stop periodically, tell the Top View observer what phase you see "from Earth," and have the Top View observer share what the Moon sphere looks like from above.
- Switch roles and repeat.

Name: _____

Date: _____

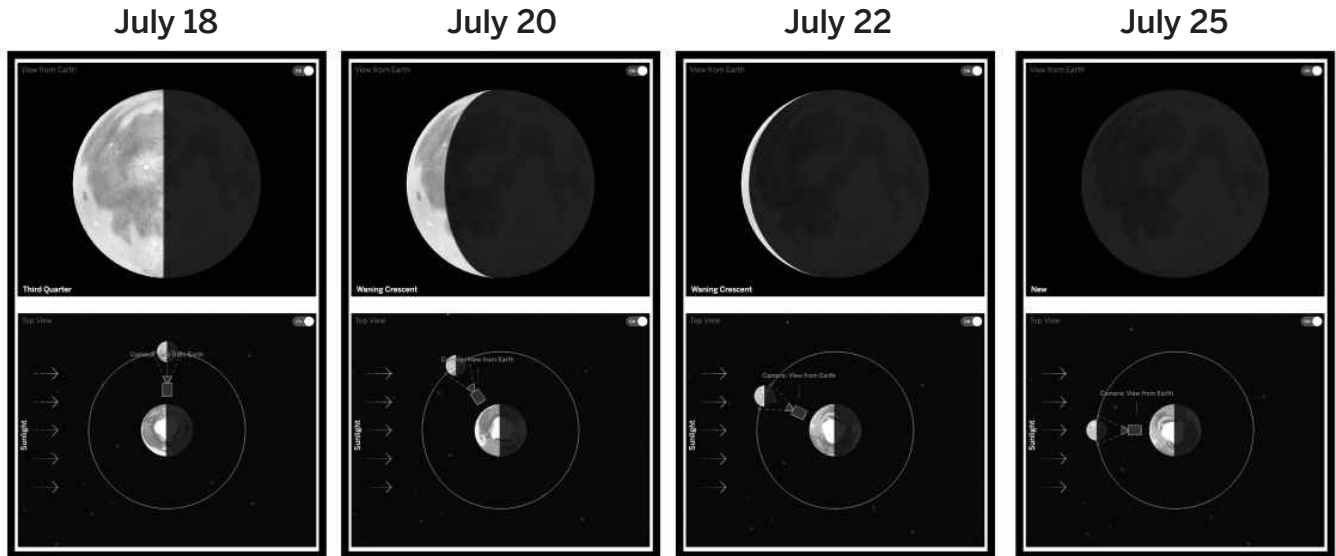
Write and Share: Discussing Moon Phases

Find the sheet on the next 3 pages that has the number you were assigned (1, 2, or 3). Follow the instructions below to participate in the Write and Share routine.

1. Carefully read and annotate the information you are given.
2. Answer your prompt, using these vocabulary words: *moon, moon phase, orbit, pattern*
3. After everyone in your group has had a chance to write, take turns introducing your prompts and sharing your responses.
4. While one student is presenting, the other two listen carefully.
5. After each student presents, the other students in the group can ask questions or make comments.

Write and Share: Student 2

Evidence source: *Earth, Moon, Sun Sim*



Prompt: How can we predict how the Moon will change appearance from day to day?

Word Bank

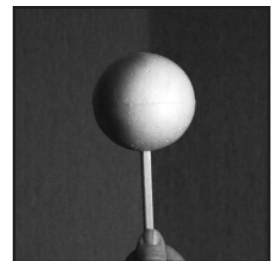
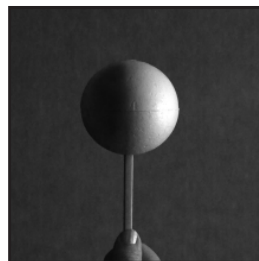
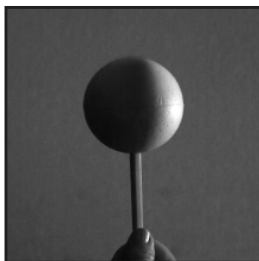
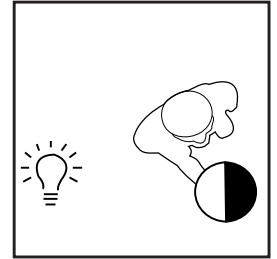
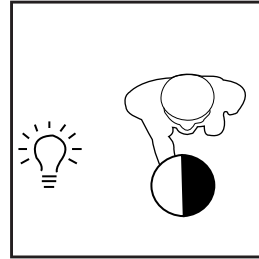
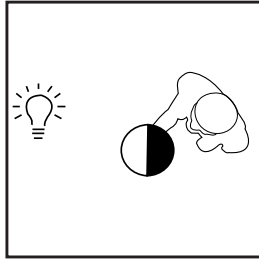
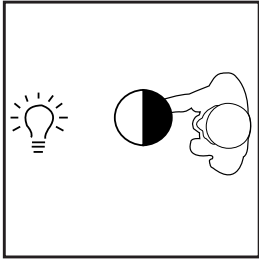
moon	moon phase	orbit	pattern
------	------------	-------	---------

Name: _____

Date: _____

Write and Share: Student 3

Evidence source: Moon Sphere Model



Prompt: How can we predict how the Moon will change appearance from day to day?

Word Bank

moon	moon phase	orbit	pattern
------	------------	-------	---------

Name: _____

Date: _____

Modeling the Order of Moon Phases

Launch the *Earth, Moon, and Sun Modeling Tool* activity: Order and Match Views.

Goal: Show which pair of Top View and View from Earth panels would come first, second, and third in time.

Do:

- Tap and drag the Top View panels to put them in the correct order.
- Tap and drag the View from Earth panels to match them to the Top View panels.

Tips:

- In all of the panels, the position of the Moon and light shapes cannot be edited.
- Need help? Turn on the Guide.
- The Top View and View from Earth panels do not start out matched.

When your model is complete, press HAND IN. Write your partner's name here if you had one:

Then, answer the questions below.

How can we predict how the Moon will change appearance from day to day?

How long does it take for the entire pattern of moon phases to be completed? (check one)

- It takes about a week.
- It takes about a month.
- It takes about a year.
- It takes a different amount of time each time the pattern repeats.

Name: _____

Date: _____

Homework: Reading “Gravity in the Solar System”

You’ve been learning about how the Moon moves around Earth. To widen your view and think about our solar system as a whole, and why planets move around the sun, read and annotate the “Gravity in the Solar System” article. Then, answer the questions below.

What is gravity?

How does gravity cause the planets to move in a circle around the sun?

How does gravity cause the solar system to move within the galaxy?

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Lesson 2.5: Orbit and the Pattern of Moon Phases

Eric Wu's deadline for *About Space* magazine is almost here! He needs to take the pictures of Rupes Cauchy, the Plato crater, and the Copernicus crater soon or he'll be out of a job. Lucky for Eric, you and your fellow student astronomers are nearly ready to make your final recommendations. Today, you'll prepare by completing a paper model that will show Eric why the border between light and dark on the Moon changes location. Then, you'll advise Eric by making a digital model of where the Moon will need to be in its orbit for him to take the photos for *About Space*.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 2 Question

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

Key Concepts

- 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 position 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.

Vocabulary

- illuminate
- model
- moon
- moon phase
- orbit
- pattern
- sun

Digital Tools

- *Earth, Moon, and Sun* Modeling Tool activity: Photographing Moon Features

Name: _____

Date: _____

Warm-Up

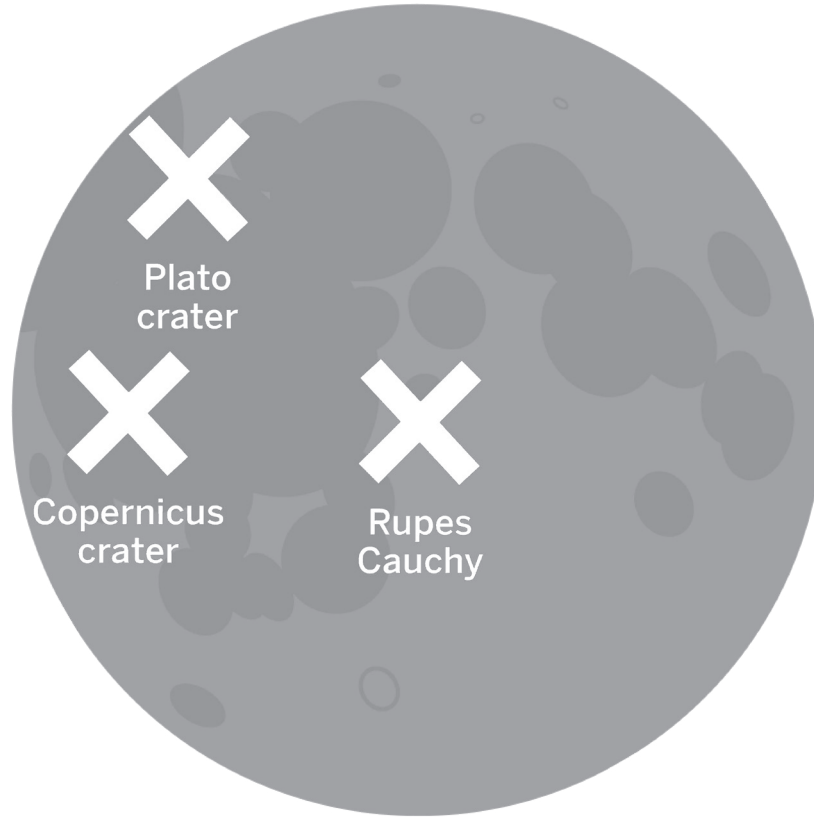
Moon Phases

Think about the experiences you have had during this chapter as you answer the Chapter 2 Question below. You will get a chance to revise your answer later in this lesson.

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

Taking Pictures of the Moon

Before you make your recommendation to Eric Wu, take a few minutes to discuss this question and these claims with your partner. Be sure to discuss which claim you think is best as well as the evidence that supports this claim.



Question: When can Eric Wu take pictures of the three Moon features?

Claim 1: Photographs of these features can be taken on any night.

Claim 2: Photographs of these features can only be taken on some nights.

Name: _____

Date: _____

Homework: Advising the Astrophotographer

Launch the *Earth, Moon, and Sun Modeling Tool* activity: Photographing Moon Features.

Goal: Show light and dark on the Moon when each moon feature will be on the terminator.

Do:

- In each View from Earth:
 - add and rotate a light shape so the terminator is on the moon feature.
- In each Top View:
 - add a Moon.
 - add and rotate a light shape over it.
 - move the Moon to the position that results in the moon phase shown in View from Earth.

Tips:

- Moon features are indicated by a red X.
- To add a Moon to Top View, tap the pencil and drag a Moon from the toolbar.
- Need help? Turn on the Guide.

When your model is complete, press HAND IN. Write your partner's name here if you had one:

When can Eric Wu take pictures of the three Moon features? (check one)

- Claim 1:** Photographs of these features can be taken on any night.
- Claim 2:** Photographs of these features can only be taken on some nights.

Explain how your model supports your claim.

Lesson 2.7: Taking on New Challenges

Student astronomers, now that you've made your recommendations to Eric Wu, it's time to put your knowledge of the Earth, Moon, and sun system toward other uses. Today, you'll work with a partner to take on a variety of new challenges, using the Sim and the key concepts from this unit to complete these tasks.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 2 Question

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

Key Concepts

- The Moon does not make its own light; the sun illuminates the Moon.
- When a model is "to scale," object sizes and distances are larger or smaller than in the real world but the same relative to one another. Some models need to be "not to scale" to be useful.
- The sun illuminates the half of the Moon that is facing it, and the other half is dark.
- Light from the sun travels in straight lines.
- 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 position 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.

Vocabulary

- illuminate
- model
- moon
- moon phase
- orbit
- pattern
- sun

Digital Tools

- *Earth, Moon, and Sun* Simulation

Name: _____

Date: _____

Warm-Up

Reviewing the Key Concepts

Look back at the key concepts that you have learned about during this unit. Then, answer the questions below.

Key Concepts

1. The Moon does not make its own light; the sun illuminates the Moon.
2. When a model is “to scale,” object sizes and distances are larger or smaller than in the real world but the same relative to one another. Some models need to be “not to scale” to be useful.
3. The sun illuminates the half of the Moon that is facing it, and the other half is dark.
4. Light from the sun travels in straight lines.
5. From Earth we can only see the half of the Moon that is facing us.
6. 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.
7. There is a pattern to the position of the Moon because the Moon orbits around Earth.
8. 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.

Pick a key concept that you understand well and explain it in a way that an elementary school student could understand.

Pick a key concept that is confusing to you and record a question below that you would need answered in order to understand it better.

Blue Group: Sim Activity

Part 1: Getting Ready for the Science Fair

Your old elementary school is having a science fair. One of your former teachers had an idea when she heard that you were learning about Earth, the Moon, and the sun. She has asked you to help one of her fourth-grade students make a physical model of the Earth, Moon, and sun system for the science fair. The student's name is Marquis, and he has a lot of questions for you about how to build a model.

Goal: Work with your partner to help Marquis, by using Top View in the Sim to answer his questions.

Do:

- Have one partner use the Sim while the other partner records the answer to one of Marquis's questions. Be sure to talk about what you see in the Sim before you record your answers. Switch roles each time you answer a question.

Tip:

- Remember to refer to the key concepts on the classroom wall. These can also help you answer Marquis's questions.

1. Marquis says, "I got some lightbulbs to use in my model. Which parts of my model should I use a lightbulb for?" (check one)

- Earth
- Moon
- sun
- none of the above

2. Use the Sim or the key concepts to explain your answer to Marquis.

Name: _____

Date: _____

Blue Group: Sim Activity (continued)

3. Marquis says, "What should the Moon look like in my model?" (check one)

- light on both sides
- light on the side facing the sun and dark on the other side
- dark on the side facing the sun and light on the other side
- dark on both sides

4. Use the Sim or the key concepts to explain your answer to Marquis.

5. Marquis says, "I want to include a drawing that shows how light moves in my model. How should I draw the light?" (check one)

- straight arrows coming from the sun
- curved arrows coming from the sun
- straight arrows coming from the Moon
- curved arrows coming from the Moon

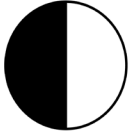
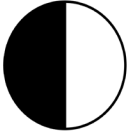
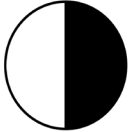
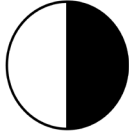

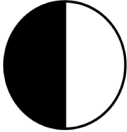
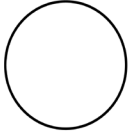
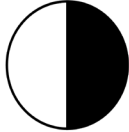
6. Use the Sim or the key concepts to explain your answer to Marquis.

Blue Group: Sim Activity (continued)

Part 2: Who did their Moon Journal homework?

Now that you've helped Marquis, your former teacher needs your help on something else. Last month, two of her students, Diana and Sameer, each had to make a Moon Journal for homework. Both students were supposed to go outside at night once each week, observe the Moon, and draw a picture to show what it looked like on that night.

When Diana and Sameer turned in their Moon Journals this morning, the teacher noticed that the drawings in each Moon Journal looked different. She thinks that one of her students did not go outside to observe the Moon at night and instead tried to draw in their Moon Journal that morning before class. The teacher would like you to identify which student recorded a series of moon phases that could not have been observed in a single month.

	Week 1	Week 2	Week 3	Week 4
Diana's Moon Journal				
	Week 1	Week 2	Week 3	Week 4
Sameer's Moon Journal				

Goal: With a partner, use the Sim to gather evidence about the appearance of the Moon to help you respond to the teacher.

Do:

- Use both Top View and View from Earth to answer the questions on the next page.
- Have one partner use the Sim while the other partner records the answer to each question. Be sure to talk about what you see in the Sim before you record your answers. Switch roles each time you answer a question.

Tips:

- Choose a single month to observe. Remember that the students only had four weeks to make their Moon Journals.
- Remember to refer to the key concepts on the classroom wall. These can also help you answer the questions.

Blue Group: Sim Activity (continued)

- How is the appearance of the Moon different in View from Earth than it is in Top View? (choose all answers that apply)
 - The appearance of the Moon changes a lot **more** in View from Earth than it does in Top View.
 - The appearance of the Moon changes a lot **less** in View from Earth than it does in Top View.
 - The Moon sometimes appears to be fully illuminated in View from Earth but **never** appears to be fully illuminated in Top View.
 - The Moon never appears to be fully illuminated in View from Earth but it **sometimes** appears to be fully illuminated in Top View.
- What determines the appearance of the Moon in View from Earth? (check one)
 - the position of the Moon around Earth
 - the position of Earth's shadow on the Moon
 - the amount of light coming from the sun
 - the direction that the light side of the Moon is facing
- How long does it take for the Moon to go around Earth? (check one)
 - about one day
 - about one week
 - about one month
 - about one year
- How often are we able to observe each moon phase? (check one)
 - about 1 or 2 times a day
 - about 1 or 2 times a week
 - about 1 or 2 times a month
 - about 1 or 2 times a year
- How long does it take for us to observe the same moon phase twice? (check one)
 - about 1 week
 - about 2 weeks
 - about 1 month
 - about 2 months

Name: _____

Date: _____

Blue Group: Sim Activity (continued)

Now that you've gathered evidence in the Sim, look back at Diana's and Sameer's Moon Journals (on page 52). Then, identify the student who needs to repeat the Moon Journal assignment next month and explain why.

Which student recorded a series of moon phases that could not have been observed in a single month? (check one)

Diana

Sameer

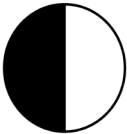
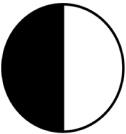
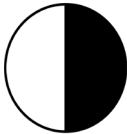


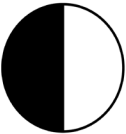
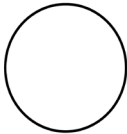
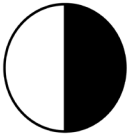
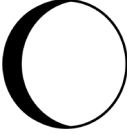

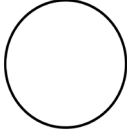

Explain why the series of moon phases that the student recorded could not have been observed in a single month. Use the evidence you gathered from the Sim or the key concepts on the classroom wall to help you explain.

Purple Group: Sim Activity

Who did their Moon Journal homework?

One of the teachers at your old elementary school heard that you were learning about the Earth, the Moon, and sun and asked you to help her with something. Last month, three of her students, Diana, Sameer, and Jordan, each had to make a Moon Journal for homework. Each student was supposed to go outside at night once each week, observe the Moon, and draw a picture to show what it looked like on that night.

When Diana, Sameer, and Jordan turned in their Moon Journals this morning, the teacher noticed that the drawings in each Moon Journal looked different. She thinks that one of her students did not go outside to observe the Moon at night and instead tried to draw in their Moon Journal that morning before class. The teacher would like you to identify which student or students recorded a series of moon phases that could not have been observed in a single month.

	Week 1	Week 2	Week 3	Week 4
Diana's Moon Journal				
Sameer's Moon Journal				
Jordan's Moon Journal				

Purple Group: Sim Activity (continued)

Goal: With a partner, use the Sim to gather evidence about the appearance of the Moon to help you respond to the teacher.

Do:

- Use both Top View and View from Earth to answer the questions below.
- Have one partner use the Sim while the other partner records the answer to each question. Be sure to talk about what you see in the Sim before you record your answers. Switch roles each time you answer a question.

Tips:

- Choose a single month to observe. Remember that the students only had four weeks to make their Moon Journals.
- Remember to refer to the key concepts on the classroom wall. These can also help you answer the questions.

1. How is the appearance of the Moon different in View from Earth than it is in Top View?

(choose all answers that apply)

- The appearance of the Moon changes a lot **more** in View from Earth than it does in Top View.
- The appearance of the Moon changes a lot **less** in View from Earth than it does in Top View.
- The Moon sometimes appears to be fully illuminated in View from Earth but **never** appears to be fully illuminated in Top View.
- The Moon never appears to be fully illuminated in View from Earth but it **sometimes** appears to be fully illuminated in Top View.

2. What determines the appearance of the Moon in View from Earth? (check one)

- the position of the Moon around Earth
- the position of Earth's shadow on the Moon
- the amount of light coming from the sun
- the direction that the light side of the Moon is facing

3. How long does it take for the Moon to go around Earth? (check one)

- about one day
- about one week
- about one month
- about one year

Name: _____

Date: _____

Purple Group: Sim Activity (continued)

4. How often are we able to observe each moon phase? (check one)
- about 1 or 2 times a day
 - about 1 or 2 times a week
 - about 1 or 2 times a month
 - about 1 or 2 times a year
5. How long does it take for us to observe the same moon phase twice? (check one)
- about 1 week
 - about 2 weeks
 - about 1 month
 - about 2 months

Now that you've gathered evidence in the Sim, look back at Diana's, Sameer's, and Jordan's Moon Journals (on page 55). Then, identify the student or students who need to repeat the Moon Journal assignment next month and explain why.

Which student or students recorded a series of moon phases that could not have been observed in a single month? (choose all that apply)

- Diana
- Sameer
- Jordan

Explain why each of the series of moon phases that the student(s) recorded could not have been observed in a single month. Use the evidence you gathered from the Sim or the key concepts on the classroom wall to help you explain.

Green Group: Sim Activity

Part 1: Seeing Phases of Earth from the Moon

The last chapter focused on the different phases of the Moon that we observe from Earth. However, the Moon is not the only object in the solar system that has phases. When astronauts visit the Moon and look back at Earth, they see phases, too! Like the phases of the Moon that we see from Earth, the phases of Earth that astronauts see from the Moon are determined by the position of the Moon in its orbit around Earth. Today, you're going to investigate the phases of Earth.

This photograph of Earth was taken by NASA astronauts from the Moon during the Apollo 8 mission in 1968. Which phase does Earth appear to be in?



Green Group: Sim Activity (continued)

Goal: With a partner, use the Sim to investigate the phases of Earth that astronauts see from the Moon.

Do:

- Use both Top View and View from Earth to answer the questions below.
- Have one partner use the Sim while the other partner records the answer to each question. Be sure to talk about what you see in the Sim before you record your answers. Switch roles each time you answer a question.

Tips:

- Move the Moon to create the phase described in each question below.
- Investigate Top View and imagine that you are an astronaut standing on the Moon and looking back at Earth.
- Remember to refer to the key concepts on the classroom wall. These can also help you answer the questions.

Complete the statements below using the word bank below.

Word Bank

new Earth phase	crescent Earth phase	quarter Earth phase
gibbous Earth phase	full Earth phase	

1. When the View from Earth is a **new moon phase**, the View from the Moon would be a _____.
2. When the View from Earth is a **full moon phase**, the View from the Moon would be a _____.
3. When the View from Earth is a **crescent moon phase**, the View from the Moon would be a _____.
4. When the View from Earth is a **quarter moon phase**, the View from the Moon would be a _____.
5. When the View from Earth is a **gibbous moon phase**, the View from the Moon would be a _____.

Name: _____

Date: _____

Green Group: Sim Activity (continued)

Part 2: Seeing Phases of Earth from the Moon

Turn back to page 58 and look at the image. Then, use what you have learned from the Sim to answer the questions.

When the astronaut took this photo of Earth, what moon phase would have been visible in View from Earth? (check one)

- new moon
- crescent moon
- quarter moon
- gibbous moon
- full moon

Explain your answer.

Where was the sun in relation to Earth when the astronaut took this photo? (check one)

- the sun was above Earth
- the sun was below Earth
- the sun was to the left of Earth
- the sun was to the right of Earth

Explain your answer.

Green Group: Sim Activity (continued)

Part 3: Seeing Phases from the Sun

So far, we've thought about seeing phases from Earth and from the Moon. But imagine for a moment that you could safely stand on the sun. What would Earth and the Moon look like to an observer on the sun?

Goal: With a partner, use the Sim to think about how Earth and the Moon would appear to an observer on the sun on May 22, 2025.

Do:

- Use both Top View and View from Earth to answer the questions below.
- Have one partner use the Sim while the other partner records the answer to each question. Be sure to talk about what you see in the Sim before you record your answers. Switch roles each time you answer a question.

Tips:

- Think about your experiences with the Moon Sphere Model. Try to imagine yourself standing just below the light at the center of the classroom and looking out at your classmates holding their Moon spheres.
- Remember to refer to the key concepts on the classroom wall. These can also help you answer the questions.

1. What moon phase would an observer on the sun see on May 22, 2025? (check one)

- new moon
- crescent moon
- quarter moon
- gibbous moon
- full moon

2. What Earth phase would an observer on the sun see on May 22, 2025? (check one)

- new Earth
- crescent Earth
- quarter Earth
- gibbous Earth
- full Earth

Name: _____

Date: _____

Green Group: Sim Activity (continued)

3. Would Earth and the Moon look different to an observer on the sun on another date in 2025?
(check one)

yes

no

Explain your answer.

Name: _____

Date: _____

Sharing Results

Reflecting on the Sim

Take a minute to think about what you learned today. As you think, ask yourself these questions:

- Did the Sim activities help you better understand any of the key concepts?
- Did the Sim activities help you learn something new?

Name: _____

Date: _____

Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

Scientists investigate in order to figure things out. You have been investigating what determines the appearance of the Moon from Earth, in order to tell astrophotographer Eric Wu when he can take photographs. Are you getting closer to understanding what determines the Moon's appearance?

1. I understand where the Moon gets its light. (check one)

yes

not yet

Explain your answer choice.

2. I understand why we see different phases of the Moon. (check one)

yes

not yet

Explain your answer choice.

3. I understand what causes the pattern of the Moon's phases. (check one)

yes

not yet

Explain your answer choice.

Name: _____ Date: _____

Homework: Check Your Understanding (continued)

4. I understand what happens during a lunar eclipse. (check one)

yes

not yet

Explain your answer choice.

5. I understand why lunar eclipses happen. (check one)

yes

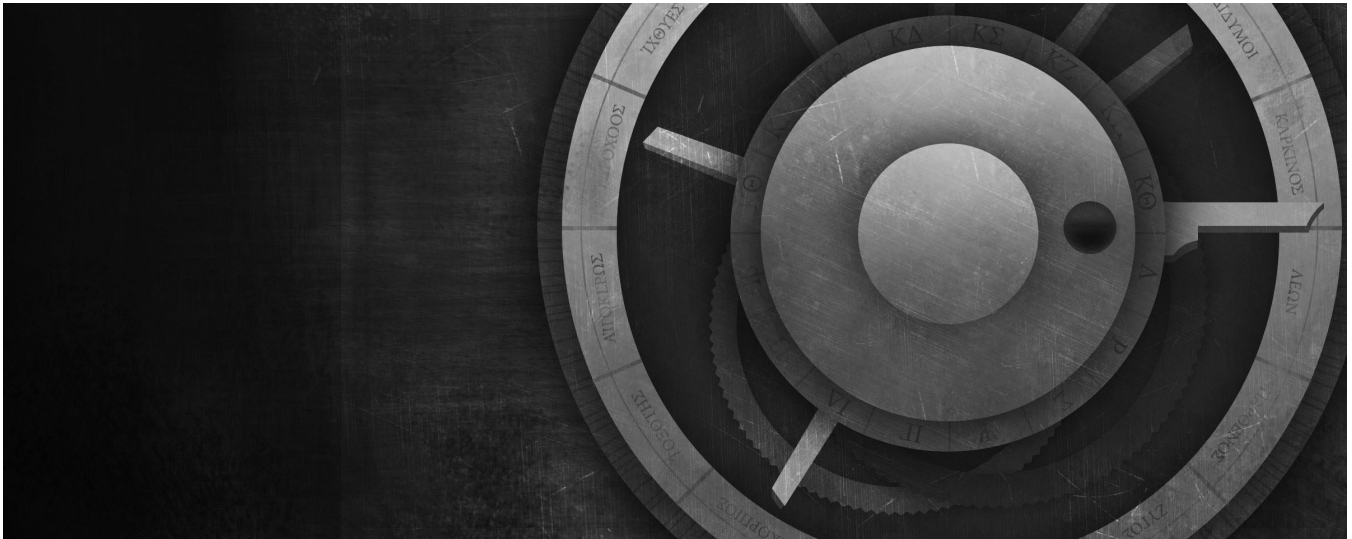
not yet

6. What do you still wonder about what determines the Moon's appearance from Earth?

Chapter 3: Lunar Eclipses

Chapter Overview

By now you know that the sun illuminates half of the Moon, whether we can see it or not. However, a lunar eclipse is a special exception to this rule. During this chapter, you'll learn why lunar eclipses happen so that you can advise Eric Wu on when to photograph one for *About Space* magazine.



Lesson 3.1: Introduction to Lunar Eclipses

Congratulations, you did a great job advising Eric Wu about moon phases! Now, he wants your help with his next assignment: photographing a lunar eclipse. Have you seen a lunar eclipse? Why would the Moon occasionally go completely dark, right in the middle of its normal path through the night sky? In today's lesson, you will be learning about lunar eclipses using the Moon Sphere Model and the *Earth, Moon, and Sun* Simulation.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 3 Question

- What are the conditions that cause a lunar eclipse?

Vocabulary

- illuminate
- lunar eclipse
- model
- moon
- moon phase
- orbit
- scale
- sun

Digital Tools

- *Earth, Moon, and Sun* Simulation
- *Earth, Moon, and Sun* Modeling Tool activity: Modeling a Lunar Eclipse

Name: _____

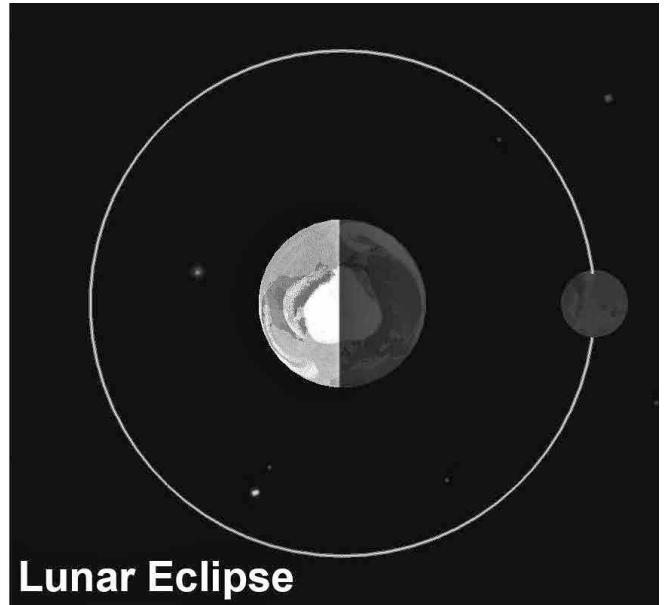
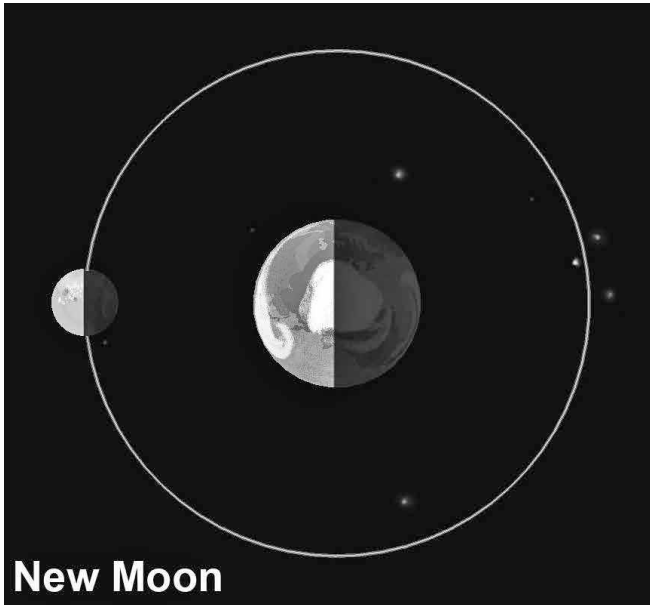
Date: _____

Warm-Up

Thinking About Lunar Eclipses

Look at the images below and then answer the question. Be sure to share your ideas with your partner.

The images below show the Moon during new moon phase and the Moon during a lunar eclipse. The images are from Top View.



How are the Moon during new moon phase and the Moon during a lunar eclipse different?

Name: _____

Date: _____

The Moon Sphere Model: Lunar Eclipses

Part 1: Corresponding with the Astrophotographer

To: Student Astronomers
From: Eric Wu, Astrophotographer
Subject: Lunar Eclipses

Thank you so much for your assistance in determining when I could photograph Rupes Cauchy and the Copernicus and Plato craters. The editors were really happy with the photographs!

Now, they have asked me to photograph a lunar eclipse for a story in the next issue. I do not know that much about lunar eclipses, so I need your assistance to help me determine when I can photograph one. I will also have to write some captions for my photos, so I will need to know some background information about what causes lunar eclipses, as well.

Part 2: Modeling an Eclipse

Work with your partner to try to model a lunar eclipse. Then, answer the questions below.

How were you able to make your Moon sphere completely dark?

Use your Moon sphere to help you complete the following statement using one of the words below:

A lunar eclipse can occur when the Moon is in _____ in its orbit.

any position

a few different positions

one position

Name: _____

Date: _____

Exploring Lunar Eclipses

Part 1: Three View Mode in the Simulation

Goal: With your partner, explore Three View Mode of the Sim and discuss what you learn about System View.

Tips:

- Use the cameras (pink camera toggle) to see how Top View and View from Earth are generated.
- Change the perspective in System View, using the slider on the left.

Part 2: Investigating Lunar Eclipses

Goal: Find a lunar eclipse in the *Earth, Moon, and Sun* Simulation and explore the different views to answer the question: *What makes the Moon completely dark during a lunar eclipse?*

Tips:

- There will be a lunar eclipse in July, August, or September in 2025.
- You may find it helpful to move time slowly, using the day and hour timeline sliders.

In the box below, draw what the System View and Top View look like in the Sim during a lunar eclipse.

Consider the positions of Earth, the Moon, and the sun as you answer the question: *What makes the Moon completely dark during a lunar eclipse?*

Name: _____

Date: _____

Homework: Modeling a Lunar Eclipse

Launch the *Earth, Moon, and Sun Modeling Tool* activity: Modeling a Lunar Eclipse.

Goal: Model a lunar eclipse by showing the positions of Earth and the Moon as well as how the Moon is illuminated.

Do:

- In the View from Earth panel:
 - add and rotate a light shape on the Moon.
- In the Top View panel:
 - place a moon in a position around Earth.
 - add and rotate a light shape on the Moon.
- In the System View panel:
 - select one of the two options to show the positions of Earth, the Moon, and the sun.

Tips:

- To edit a panel, press the pencil.
- You can add a light shape to Earth, but you do not need to.
- You'll be revising this model in Lesson 3.3.

If you have any new ideas after completing your model, take time to revise your earlier answer to the question: *What makes the Moon completely dark during a lunar eclipse?*

Name: _____

Date: _____

Homework: Reading “The Endless Summer of the Arctic Tern”

You have been focused on the Moon and how it appears at different times according to the positions of the Earth, Moon, and sun. To learn about another important phenomenon that results from the changing position of the Earth relative to the sun, read and annotate the “The Endless Summer of the Arctic Tern” article. Then, answer the questions below.

Why are there seasons on Earth?

Why is there one winter and one summer each year?

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Lesson 3.2: Reading About Predicting Eclipses

Today, you will read an article about an ancient mechanism used to predict many things about the movement of the planets. You will be using Active Reading strategies to read and annotate the article and then share your thinking with your classmates. Information from this article will help you understand why lunar eclipses happen when they do, which you'll need to know if you want to advise Eric Wu about when eclipses can be photographed.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 3 Question

- What are the conditions that cause a lunar eclipse?

Key Concepts

- 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 in between the sun and the Moon.

Vocabulary

- illuminate
- lunar eclipse
- moon
- moon phase
- orbit
- pattern
- sun

Warm-Up

Thinking About Eclipses

Think about what you have learned from the Moon Sphere Model and the Simulation activities as you answer the questions below.

Image 1

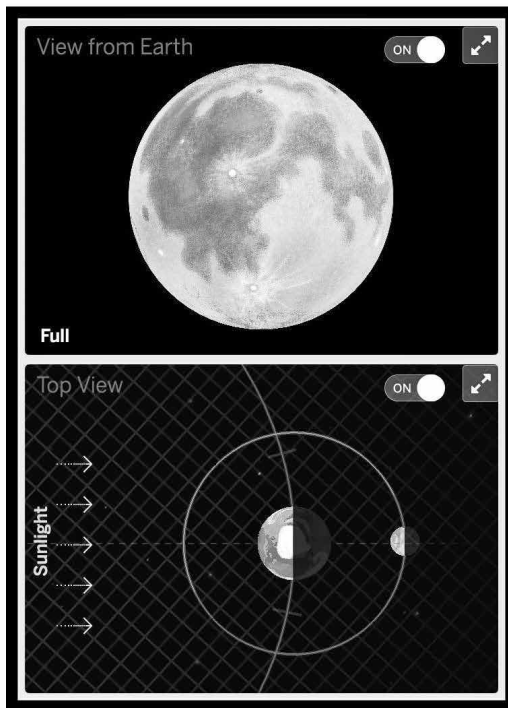
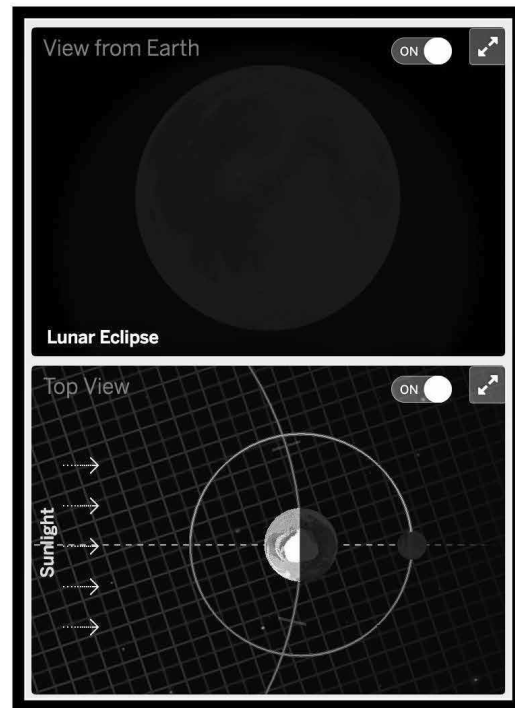


Image 2



Why is a lunar eclipse happening in Image 2? (check one)

- The Moon is directly in between Earth and the sun, in a straight line.
- The illuminated half of the Moon is facing away from Earth.
- The Moon is far away from the sun, so the sun's light is weaker.
- Earth is blocking the sun's light from hitting the Moon.

If Earth is in between the sun and the Moon in both Image 1 and Image 2, why do you think a lunar eclipse is only happening in Image 2?

Name: _____

Date: _____

Reading “An Ancient Machine for Predicting Eclipses”

1. Read and annotate the article “An Ancient Machine for Predicting Eclipses.”
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

What is something about the text that you discussed with your partner?

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____

Date: _____

Homework: Making Connections

Think of another science topic you studied earlier. How might considering scale be useful when investigating that topic? How is that similar to and different from how the crosscutting concept of Scale is useful in this unit?

Lesson 3.3: Gathering Evidence About Lunar Eclipses

Student astronomers, in the last lesson you read about the Antikythera mechanism, an ancient set of metal gears used more than 2,000 years ago to predict lunar eclipses. But why are lunar eclipses so hard to predict in the first place? Why don't lunar eclipses happen every month, like the phases of the Moon that you learned about in Chapter 2? Today, you'll use the Sim and revisit "An Ancient Machine for Predicting Eclipses" to gather evidence about these questions.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 3 Question

- What are the conditions that cause a lunar eclipse?

Key Concepts

- 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 in between the sun and the Moon.

Vocabulary

- illuminate
- lunar eclipse
- model
- moon
- moon phase
- orbit
- sun

Digital Tools

- *Earth, Moon, and Sun* Simulation
- *Earth, Moon, and Sun* Modeling Tool activity: Modeling a Lunar Eclipse
- *Earth, Moon, and Sun* Modeling Tool activity: Modeling a Full Moon

Name: _____

Date: _____

Warm-Up

During this lesson, you will have a chance to gather evidence that will help you answer the Investigation Question. However, scientists often start an investigation by making a claim based on their initial ideas about a question.

Think about the Investigation Question and write your initial claim about it below. You will get a chance to revise your claim at the end of this lesson.

Why isn't there a lunar eclipse every time Earth is in between the sun and the Moon?

Name: _____

Date: _____

Gathering Evidence from the Sim

Goal: With a partner, use the *Earth, Moon, and Sun* Simulation to gather evidence that will help you answer the Investigation Question.

Do:

- One partner will find a lunar eclipse in July, August, or September and display it on his device.
- One partner will find a full moon in July, August, or September and display it on her device.
- Partners will use both devices to compare the positions of Earth, the Moon, and the sun during a lunar eclipse and during a full moon.
- Partners discuss any similarities or differences that might help answer the Investigation Question.

Tips:

- Be sure to use both System View and Top View when comparing the lunar eclipse and the full moon.
- Use the slider on the left-hand side of the screen in System View to change the perspective.
- Record your evidence by writing or drawing your observations in the space below.

Investigation Question: *Why isn't there a lunar eclipse every time Earth is in between the sun and the Moon?*

Name: _____

Date: _____

Gathering Evidence from a Text

Reread the last paragraph of “An Ancient Machine for Predicting Eclipses.” As you read, highlight or make annotations about any evidence that might help you explain why there isn’t a lunar eclipse every time Earth is in between the sun and the Moon. Then, discuss this evidence with your partner and share your current ideas about the Investigation Question.

Investigation Question: *Why isn’t there a lunar eclipse every time Earth is in between the sun and the Moon?*

Name: _____

Date: _____

Modeling a Lunar Eclipse and a Full Moon

Part 1: Modeling a Lunar Eclipse

Goal: Review your model in the *Earth, Moon, and Sun* Modeling Tool activity: Modeling a Lunar Eclipse. If necessary, revise this model so that it shows your current thinking about lunar eclipses.

When your model is complete, press HAND IN. Write your partner's name here if you had one:

Part 2: Modeling a Full Moon

Goal: Complete the *Earth, Moon, and Sun* Modeling Tool activity: Modeling a Full Moon. Model a full moon by showing the positions of Earth and the Moon and how the Moon is illuminated.

Do:

- In the View from Earth panel:
 - add and rotate a light shape on the Moon.
- In the Top View panel:
 - place a moon in a position around Earth.
 - add and rotate a light shape on the Moon.
- In the System View panel:
 - select one of the two options to show the positions of Earth and the Moon.

Tips:

- To edit a panel, press the pencil.
- You can add a light shape to Earth, but you do not need to.

When your model is complete, press HAND IN. Write your partner's name here if you had one:

_____. Then, answer the question below.

Revise your Warm-Up response to the question: *Why isn't there a lunar eclipse every time Earth is in between the sun and the Moon?*

Name: _____

Date: _____

Homework: Exploring Solar Eclipses

You've learned how to predict and explain lunar eclipses. Can you use what you've learned to try to explain another kind of eclipse, a solar eclipse?

1. Start by writing your initial ideas about solar eclipses. What are they? When do you think they happen?

2. Find and observe a solar eclipse in the *Earth, Moon, and Sun* Simulation. **Hint:** One takes place on September 21. Describe what you observed.

3. Solar eclipses happen when the Moon is in **full moon phase** / **new moon phase** / **any phase**. (circle one)

4. Why don't solar eclipses happen every time the Moon is in between the sun and Earth?

Lesson 3.4: When and Why We See Lunar Eclipses

This is it! Eric Wu needs to know when and why lunar eclipses happen and, by the end of this lesson, you'll be ready to tell him. In the meantime, you and your fellow student astronomers will review the evidence you have gathered throughout this chapter and discuss how it can be used to make the most convincing argument for Eric. Will Eric get the photos he needs and make his deadline for *About Space* magazine? It's up to you, student astronomers!

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 3 Question

- What are the conditions that cause a lunar eclipse?

Key Concepts

- 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 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.

Vocabulary

- illuminate
- lunar eclipse
- model
- moon
- moon phase
- orbit
- pattern
- sun

Warm-Up

Two Claims About Lunar Eclipses

Read the story below about Chloe and Khalil, two students from another school who are also learning about the Earth, Moon, and sun. Then, answer the question below.

Chloe is a photographer for the school newspaper. After learning about Eric Wu's assignment for *About Space* magazine, she decided to try to take her own picture of a lunar eclipse for the school newspaper. However, on the night of the lunar eclipse, Chloe wasn't feeling well, so her parents wouldn't let her go outside with her camera.

The next day at school, Chloe was feeling disappointed, so her friend Khalil tried to cheer her up. "Don't worry," he said. "Remember, we learned that the Moon moves in the same circle around Earth each month. That means you can photograph a lunar eclipse when Earth is in between the sun and the Moon again next month."

"Maybe, but maybe not," Chloe said. "A lunar eclipse happens sometimes when Earth is in between the sun and the Moon, but not always. It could be a long time before I have another opportunity to take a picture of a lunar eclipse."

When can a lunar eclipse be photographed? (check one)

- Claim 1:** A lunar eclipse can be photographed any time Earth is in between the sun and the Moon.
- Claim 2:** A lunar eclipse can be photographed sometimes when Earth is in between the sun and the Moon.

Name: _____

Date: _____

Write and Share Routine: Discussing Lunar Eclipses

Find the sheet on the next 3 pages that has the number you were assigned (1, 2, or 3). Follow the instructions below to participate in the Write and Share routine.

1. Carefully read and annotate the information you are given.
2. Answer your prompt, using these vocabulary words: *moon*, *moon phase*, *orbit*, *pattern*.
3. After everyone in your group has had a chance to write, take turns introducing your prompts and sharing your responses.
4. While one student is presenting, the other two listen carefully.
5. After each student presents, the other students in the group can ask questions or make comments.

Name: _____

Date: _____

Write and Share Routine: Student 1

Evidence source: “An Ancient Machine for Predicting Eclipses” article

“Today astronomers can explain why lunar eclipses happen when they do. Lunar eclipses are caused by Earth blocking sunlight from reaching the Moon. For Earth to block the sunlight, it has to be between the sun and the Moon. Not only that, but the sun, Earth, and the Moon have to line up exactly, with Earth in the middle. When they line up in this way, Earth blocks the sunlight and the Moon goes dark. Eclipses only happen on the night of a full moon, because the full moon is the phase when the sun, Earth, and the Moon line up with Earth in the middle.”

Prompt: What are the conditions that cause a lunar eclipse?

Word Bank

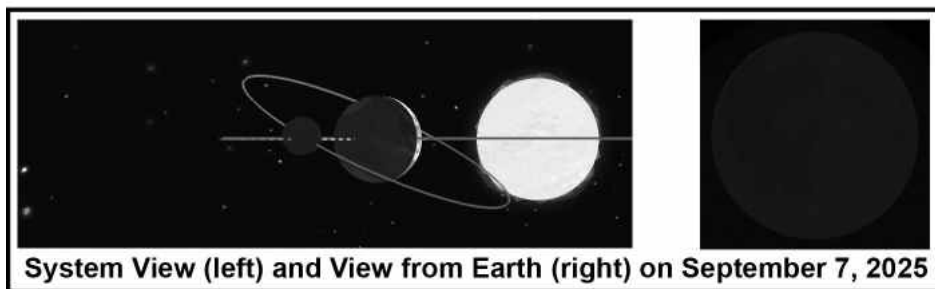
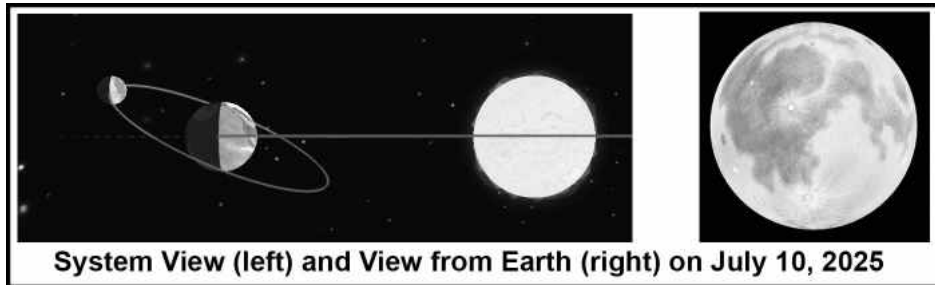
illuminate	lunar eclipse	moon
orbit	sun	

Name: _____

Date: _____

Write and Share Routine: Student 2

Evidence source: *Earth, Moon, and Sun Sim*



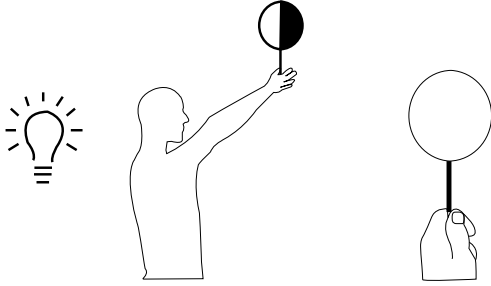
Prompt: What are the conditions that cause a lunar eclipse?

Word Bank

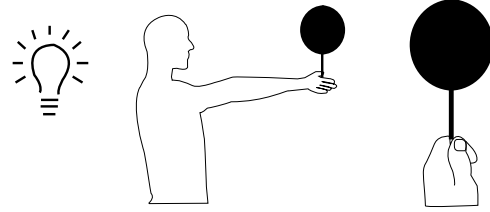
illuminate	lunar eclipse	moon
orbit	sun	

Write and Share Routine: Student 3

Evidence source: Moon Sphere Model



Moon Sphere Model: Position #1



Moon Sphere Model: Position #2

Prompt: What are the conditions that cause a lunar eclipse?

Word Bank

illuminate	lunar eclipse	moon
orbit	sun	

Name: _____

Date: _____

Reasoning About Photographing an Eclipse

With your group, use the Reasoning Tool to connect each piece of evidence to the claim you think is correct.

Question: When can a lunar eclipse be photographed?

Claim 1: A lunar eclipse can be photographed anytime Earth is in between the sun and the Moon.

Claim 2: A lunar eclipse can be photographed sometimes when Earth is in between the sun and the Moon.

Evidence	This matters because . . .	Therefore, . . . (claim)
Example evidence: Two Top View images		
Evidence source: “An Ancient Machine for Predicting Eclipses” article		
Evidence source: <i>Earth, Moon, and Sun Sim</i>		
Evidence source: Moon Sphere Model		

Name: _____

Date: _____

Homework: Advising the Astrophotographer

Use the evidence you discussed with your group during the Write and Share routine and recorded in the Reasoning Tool to help you write a message to Eric Wu about photographing a lunar eclipse. You may wish to use some of the vocabulary words listed in the word bank below to help you write.

Question: When can a lunar eclipse be photographed?

Claim 1: A lunar eclipse can be photographed anytime Earth is in between the sun and the Moon.

Claim 2: A lunar eclipse can be photographed sometimes when Earth is in between the sun and the Moon.

Word Bank

illuminate	lunar eclipse	moon
orbit	sun	model

Write a message to Eric Wu explaining when he can photograph a lunar eclipse and why lunar eclipses happen.

- First, state your claim about when a lunar eclipse can be photographed.
- Then, use evidence to support your claim. For each piece of evidence you use, explain how the evidence supports your claim.

Name: _____

Date: _____

Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

Scientists investigate in order to figure things out. You have been investigating what determines the appearance of the Moon from Earth, in order to tell astrophotographer Eric Wu when he can take photographs. Are you getting closer to understanding what determines the Moon's appearance?

1. I understand where the Moon gets its light. (check one)

yes

not yet

Explain your answer choice.

2. I understand why we see different phases of the Moon. (check one)

yes

not yet

Explain your answer choice.

3. I understand what causes the pattern of the Moon's phases. (check one)

yes

not yet

Explain your answer choice.

Name: _____ Date: _____

Homework: Check Your Understanding (continued)

4. I understand what happens during a lunar eclipse. (check one).

yes

not yet

Explain your answer choice.

5. I understand why lunar eclipses happen. (check one)

yes

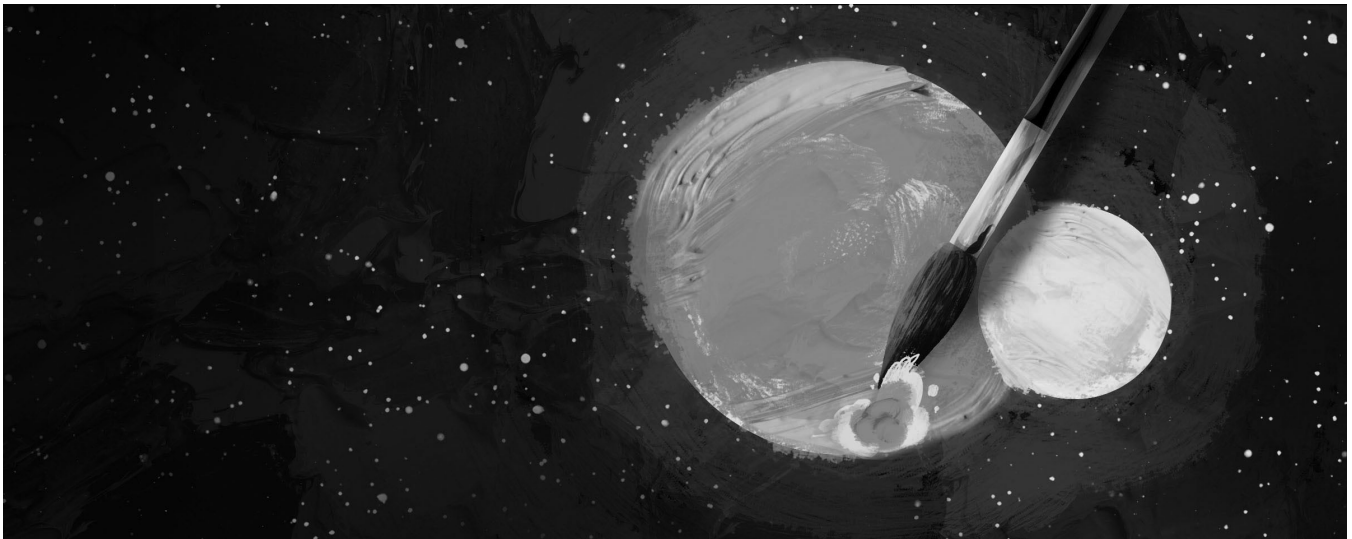
not yet

6. What do you still wonder about what determines the Moon's appearance from Earth?

Chapter 4: Science Seminar

Chapter Overview

Now that you've contributed to two articles about Earth, the Moon, and the sun, the staff at *About Space* magazine wants you to help them design some illustrations for their next issue. This time, the subject is Kepler-47c, a newly discovered planet that is outside our solar system.



Lesson 4.1: Lunar Eclipses Outside Our Solar System

Student astronomers, your work with Eric Wu has made you a valuable contributor to *About Space* magazine. Now, your help is needed once again. The editors are planning to include an article about Kepler-47c, a newly discovered planet outside of our solar system, in a new issue. The artist in charge of illustrating this article wants to show a lunar eclipse of Kepler-47c's moon. Do lunar eclipses even happen on Kepler-47c? The staff at *About Space* has collected some information about Kepler-47c, but they need your help to figure out what it all means.

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 4 Question

- During a year, will there be a lunar eclipse of the moon of Kepler-47c?

Vocabulary

- claim
- evidence
- illuminate
- lunar eclipse
- model
- moon
- orbit
- reasoning
- scale
- scientific argument
- sun

Name: _____

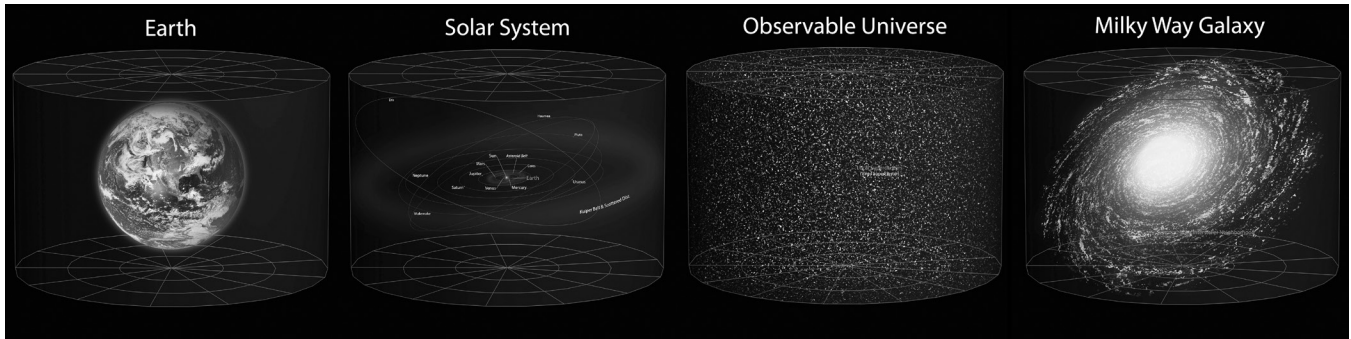
Date: _____

Warm-Up

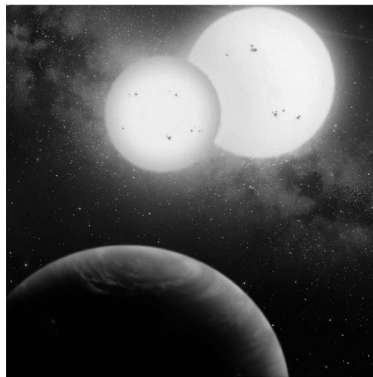
Imagining Other Worlds

Our solar system is just one of many star systems in our galaxy, the Milky Way galaxy. The Milky Way galaxy is just one of many galaxies in the universe. What are other star systems and galaxies like?

Look at the images below and answer the questions. Then, share your ideas with your partner.



How do you think other galaxies might be similar or different from the Milky Way galaxy?



How is this star system different from our solar system?

What do you think would be different if you were on a planet in this star system?

Analyzing Evidence

Part 1: Analyzing Evidence Card A

Examine Evidence Card A. Annotate the card to help you think about the evidence. Then, discuss the evidence with your partner, using the discussion questions below.

Discuss the following questions with your partner:

- Is a lunar eclipse of Kepler-47c's moon possible, based on this evidence?
- Is a lunar eclipse of Kepler-47c's moon likely to happen, based on this evidence?

Part 2: Drawing Lunar Eclipses

1. Read the instructions on the top of Drawing Activity: Part 1 (on page 97).
2. When you are done with Part 1, you will begin Part 2 on (page 98).
3. Be sure to discuss the Drawing Activities with your partner, using the discussion questions below as you work. When you are finished, answer the questions below.

As you work, it may be helpful to think about this key concept:

- *The Moon is only completely dark when the sun, Earth, and the Moon are in a straight line, with Earth in the middle.*

As you work on drawing the Moon's positions around Earth, discuss the following questions with your partner:

- **For Part 1:** In how many of Earth's positions is a lunar eclipse possible?
- **For Part 2:** In how many of Kepler-47c's positions is a lunar eclipse possible?

Questions

Based on this Drawing Activity, do you think a lunar eclipse of the moon of Kepler-47c is possible? (check one)

yes

no

Based on this Drawing Activity, which of these events do you think is most likely to happen? (check one)

a lunar eclipse of Earth's Moon

a lunar eclipse of Kepler-47c's moon

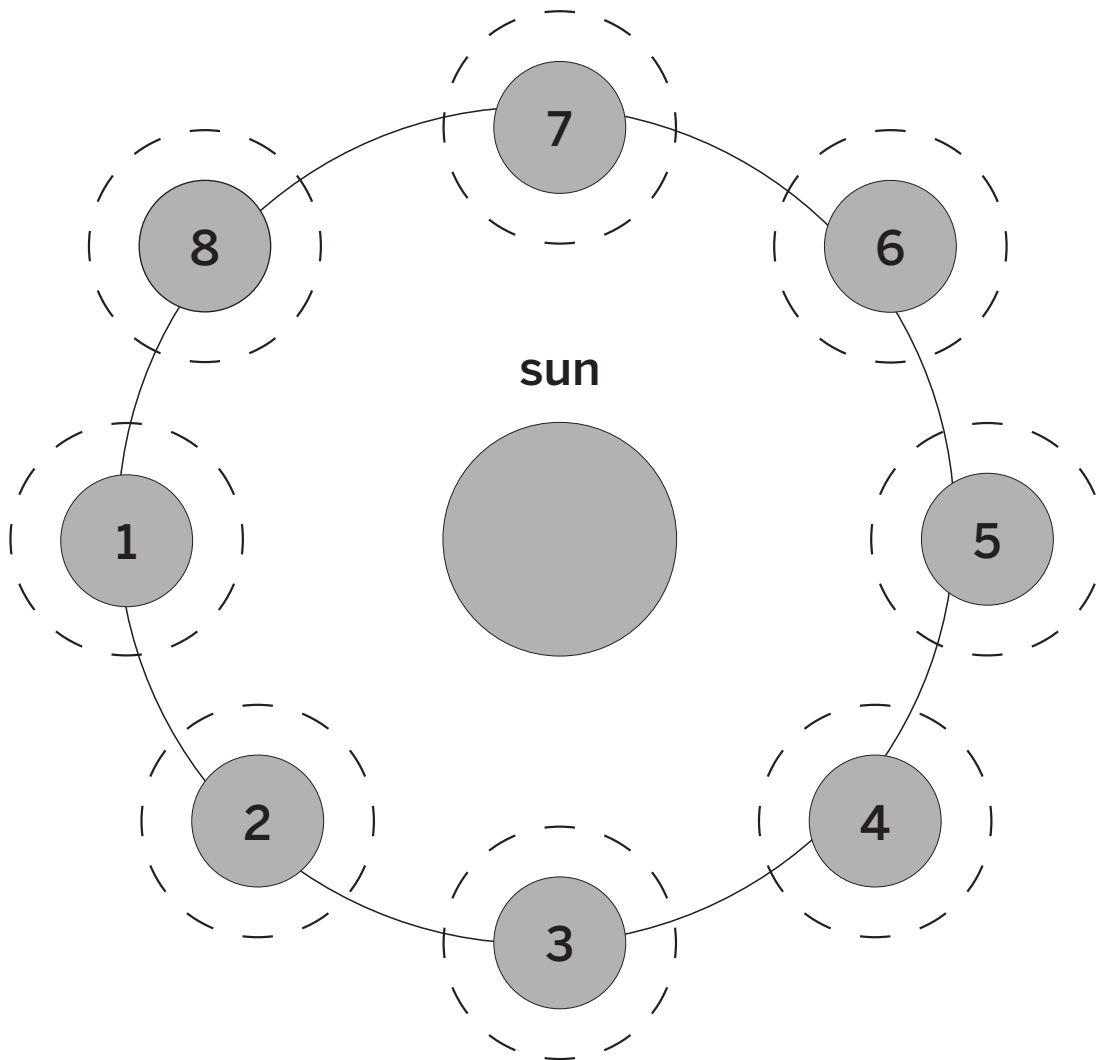
both are equally likely

Drawing Activity

Part 1: The diagram below shows Earth in eight different positions in its orbit around the sun. Around each of Earth's positions is a dashed circle representing the Moon's orbit.

- For each of Earth's positions (1–8), try to draw the Moon in a position on the dashed circle where a lunar eclipse could happen.
- Then, check the boxes (below the diagram) for each position in which a lunar eclipse could happen.

Note: This diagram is not to scale.



A lunar eclipse could happen when Earth is in:

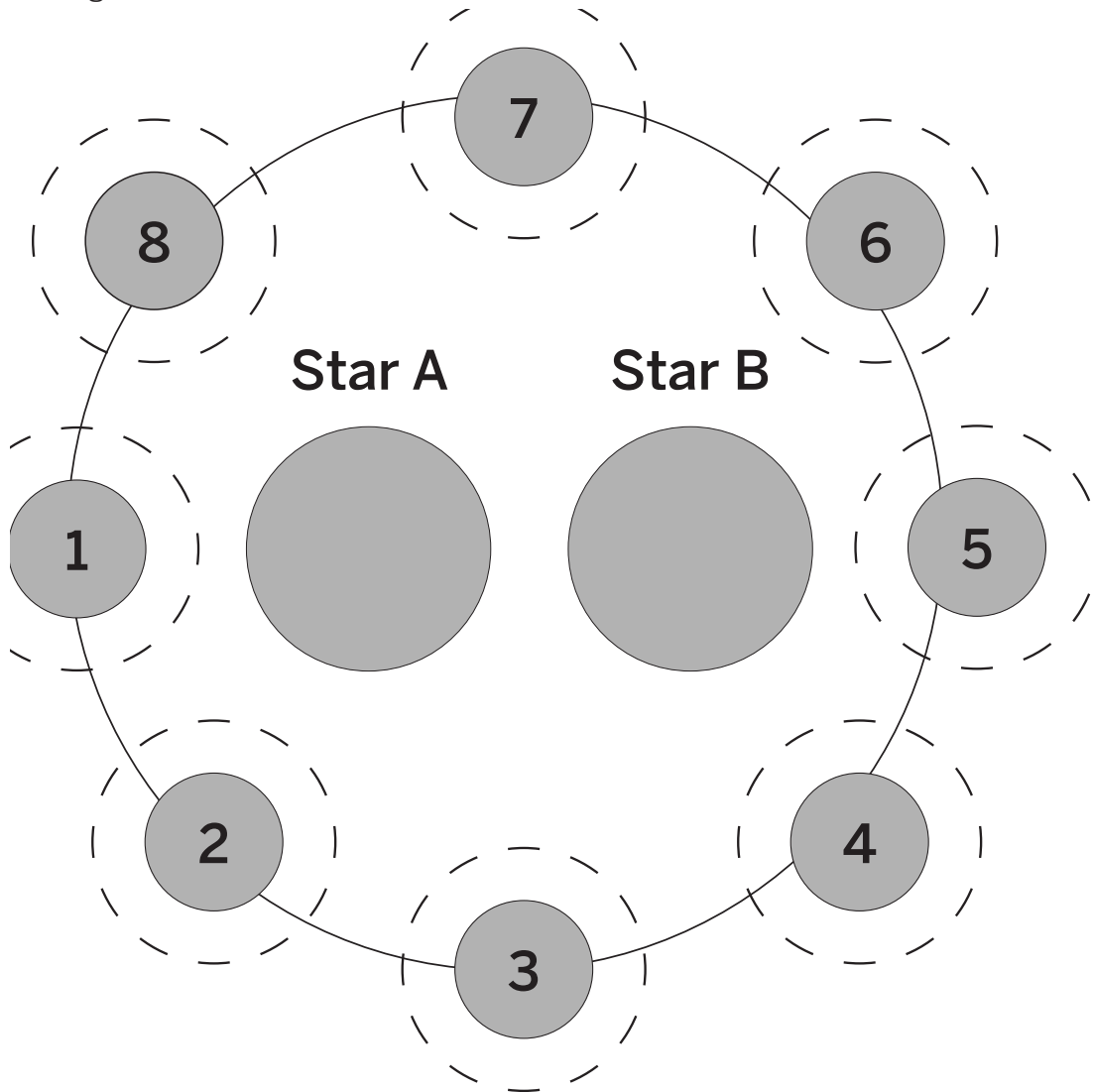
- | | | | |
|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> Position 1 | <input type="checkbox"/> Position 3 | <input type="checkbox"/> Position 5 | <input type="checkbox"/> Position 7 |
| <input type="checkbox"/> Position 2 | <input type="checkbox"/> Position 4 | <input type="checkbox"/> Position 6 | <input type="checkbox"/> Position 8 |

Drawing Activity (continued)

Part 2: The diagram below shows Kepler-47c in eight different positions in its orbit around Stars A and B. Around each of Kepler-47c's positions is a dashed circle representing its moon's orbit.

1. For each of Kepler-47c's positions (1–8), try to draw its moon in a position on the dashed circle where a lunar eclipse could happen.
2. Then, check the boxes (below the diagram) for each position in which a lunar eclipse could happen.

Note: This diagram is not to scale.



A lunar eclipse could happen when Kepler-47c is in:

- | | | | |
|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> Position 1 | <input type="checkbox"/> Position 3 | <input type="checkbox"/> Position 5 | <input type="checkbox"/> Position 7 |
| <input type="checkbox"/> Position 2 | <input type="checkbox"/> Position 4 | <input type="checkbox"/> Position 6 | <input type="checkbox"/> Position 8 |

Name: _____

Date: _____

Analyzing Evidence (continued)

Part 3: Analyzing Evidence Cards B and C

Examine Evidence Cards B and C. Annotate the cards to help you think about the evidence. Then, discuss the evidence with your partner, using the discussion questions below.

Discuss the following questions with your partner:

Card B: If a moon's orbit is tilted, will a lunar eclipse happen every time the planet is between the moon and the star? What if a moon's orbit is not tilted?

Card C: How does the number of moon orbits per year affect the number of lunar eclipses per year?

Sorting Evidence

1. Place the Science Seminar Question at the top of your desk.
2. Place the two claims, side by side, underneath the question.
3. With a partner, discuss whether each piece of evidence supports or goes against the claims. Use the sentence starters below to help you discuss this with your partner.
4. Make annotations on each card.
 - If the evidence supports a claim, write “supports Claim 1 or 2” on that card.
 - If the evidence goes against a claim, write “goes against Claim 1 or 2” on that card.
 - If the evidence connects with another evidence card, write “connects with Evidence Card A, B, or C” on that card.
5. Sort the evidence by placing the cards under the claim they support.

Sentence Starters

I think this piece of information supports this claim because . . .

I don't think this piece of information supports this claim because . . .

I agree because . . .

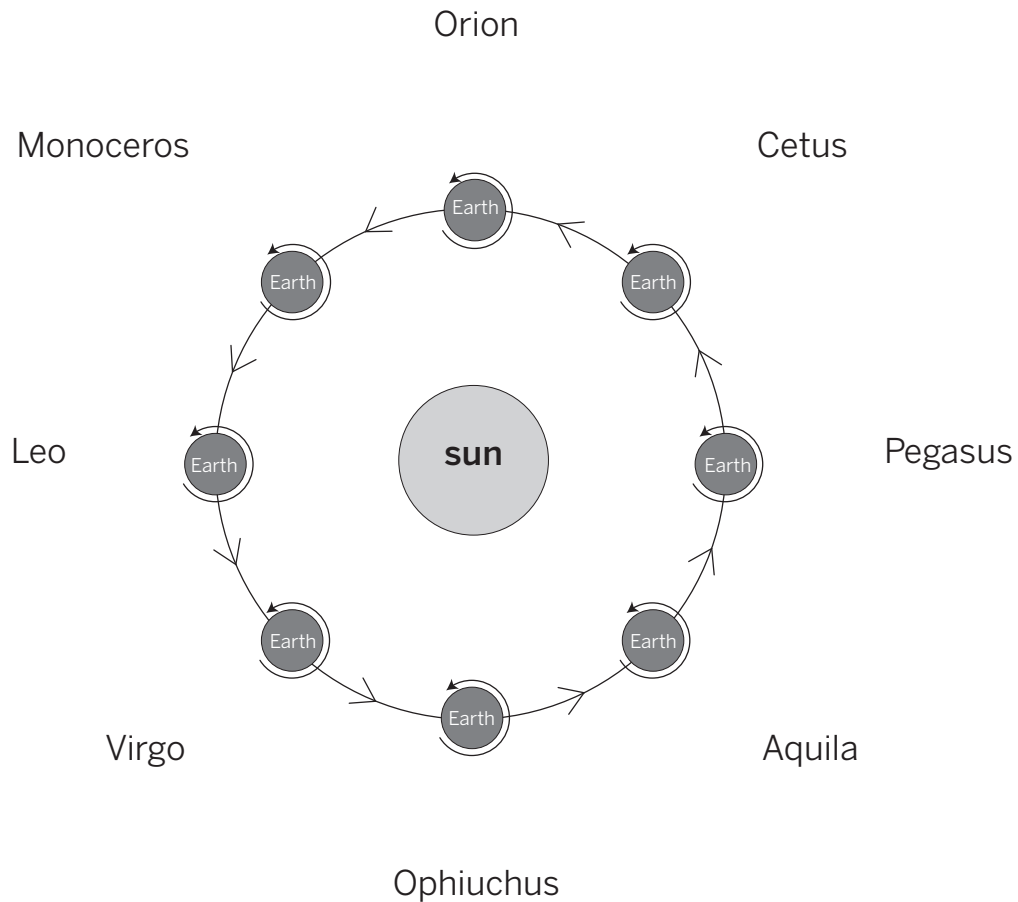
I disagree because . . .

Why do you think that?

Homework: Why the Stars Seem to Move

The diagram below shows how Earth rotates and how Earth orbits around the sun, as well as the names of eight constellations, each in a different direction from the sun. Use the diagram to help you answer the questions below.

Note: This diagram is not to scale.



Why do the stars seem to rise and set each day?

Why do we see different constellations at different times of year?

Lesson 4.2: Discussing Eclipses in a Two-Star System

Will there be a lunar eclipse of the moon of Kepler-47c? Today, you'll discuss this question, using what you know about lunar eclipses in the Earth, Moon, and sun system and the evidence about Kepler-47c to build an argument. Are lunar eclipses possible in a two-star system? Are they likely? It's now time to make your case, student astronomers!

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 4 Question

- During a year, will there be a lunar eclipse of the moon of Kepler-47c?

Key Concepts

- The Moon does not make its own light; the sun illuminates the Moon.
- When a model is “to scale,” object sizes and distances are larger or smaller than in the real world but the same relative to one another. Some models need to be “not to scale” to be useful.
- The sun illuminates the half of the Moon that is facing it, and the other half is dark.
- Light from the sun travels in straight lines.
- 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 position 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.
- 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 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.

Name: _____

Date: _____

Lesson 4.2: Discussing Eclipses in a Two-Star System (continued)

Vocabulary

- claim
- evidence
- illuminate
- lunar eclipse
- model
- moon
- orbit
- reasoning
- scale
- scientific argument
- sun

Name: _____

Date: _____

Warm-Up

Revisiting the Evidence

Review your sorted Science Seminar Evidence cards from the previous lesson. Then, use the evidence cards to answer the questions below.

Which claim do you think is the most convincing? (check one)

- Claim 1:** Yes, there probably will be a lunar eclipse.
- Claim 2:** No, there probably won't be a lunar eclipse.

Draw a star on the evidence card that best supports your claim. Why did you choose this piece of evidence?

Preparing a Science Seminar Argument

1. With your partner, take turns sharing which claim you think is the most convincing.
2. Use your Warm-Up responses and the Scientific Argument Sentence Starters to help you share ideas.
3. Refer to the Science Seminar Evidence cards as needed.

During a year, will there be a lunar eclipse of the moon of Kepler-47c? (check one)

- Claim 1:** Yes, there probably will be a lunar eclipse.
- Claim 2:** No, there probably won't be a lunar eclipse.

Scientific Argument Sentence Starters

<p>Describing evidence:</p> <p>The evidence that supports (or refutes) my claim is . . .</p> <p>My first piece of evidence is . . .</p> <p>Another piece of evidence is . . .</p> <p>This evidence shows that . . .</p>	<p>Explaining how the evidence supports the claim:</p> <p>If ____, then . . .</p> <p>This is important because . . .</p> <p>Since, . . .</p> <p>Based on the evidence, I conclude that . . .</p> <p>This claim is stronger (or weaker) because . . .</p>
--	---

Name: _____

Date: _____

Science Seminar Observations

Write a check mark in the right-hand column every time you hear one of your peers say or do something listed in the left-hand column. If you hear an interesting idea, write it in the last row of the table.

Observations during the seminar	Check marks
I heard a student use evidence to support a claim.	
I heard a student respectfully disagree with someone else's thinking.	
I heard a student explain how her evidence is connected to her claim.	
I heard a student evaluate the quality of evidence.	
I heard an idea that makes me better understand one of the claims. That idea is:	

Name: _____

Date: _____

Homework: Reflecting on the Science Seminar

Now that the Science Seminar is over, think back on the claim you selected at the beginning of the lesson. After participating in the discussion, you may have changed your mind about which claim you think is best supported. Show your current thinking by answering the questions below.

Which claim do you now think is the most convincing? (check one)

- Claim 1:** Yes, there probably will be a lunar eclipse.
- Claim 2:** No, there probably won't be a lunar eclipse.

Did the Science Seminar cause your thinking about the claims to change? Explain your answer.

Lesson 4.3: Writing a Scientific Argument

Student astronomers, you've discussed the claims and the evidence about Kepler-47c and its moon. Now, it's time for you to make your case in writing. Today, you'll review the evidence and use the Reasoning Tool to organize your thinking. Then, you'll write a scientific argument to Amasha Oda, the artist at *About Space* magazine, stating whether you think there will be a lunar eclipse of Kepler-47c's moon. Get ready to defend your claim, student astronomers!

Unit Question

- What determines the appearance of the Moon from Earth?

Chapter 4 Question

- During a year, will there be a lunar eclipse of the moon of Kepler-47c?

Key Concepts

- The Moon does not make its own light; the sun illuminates the Moon.
- When a model is “to scale,” object sizes and distances are larger or smaller than in the real world but the same relative to one another. Some models need to be “not to scale” to be useful.
- The sun illuminates the half of the Moon that is facing it, and the other half is dark.
- Light from the sun travels in straight lines.
- 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 position 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.
- 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 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.

Name: _____

Date: _____

Lesson 4.3: Writing a Scientific Argument (continued)

Vocabulary

- claim
- evidence
- illuminate
- lunar eclipse
- model
- moon
- orbit
- reasoning
- scale
- scientific argument
- sun

Warm-Up

Dina and Calais are two students studying about Earth, the Moon, and the sun at another school. Dina and Calais both used the Reasoning Tool to make their own arguments about why we see moon phases. As you read and compare these two arguments, pay close attention to the middle column. Then, answer the questions on the next page.

Dina's argument

Evidence	This matters because . . . (How does this evidence support the claim?)	Therefore, . . . (claim)
When the Moon moves in Top View in the Sim, we see different moon phases in the View from Earth.	What we see depends on the position of the Moon. This position determines how much of the illuminated half of the Moon we can see from Earth.	We see moon phases because the Moon moves around Earth.

Calais's argument

Evidence	This matters because . . . (How does this evidence support the claim?)	Therefore, . . . (claim)
When the Moon moves in Top View in the Sim, we see different moon phases in the View from Earth.	The different phases of the Moon that we can see are new moon, crescent moon, quarter moon, gibbous moon, and full moon.	We see moon phases because the Moon moves around Earth.

Name: _____

Date: _____

Warm-Up (continued)

Which argument is more convincing? (check one)

Dina's argument

Calais's argument

What makes one argument more convincing than the other?

Name: _____

Date: _____

Using the Reasoning Tool to Support Your Claim

Why is reasoning important?

After scientists state a claim, they connect evidence to the claim in the reasoning process. **This makes their argument convincing.**

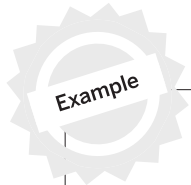
Use the Science Seminar Reasoning Tool sheet to explain how the evidence supports your claim. Follow the instructions below.

1. Record the claim that you think is best supported by the evidence (in the **Therefore, . . .** column). If you prefer, you can also write and record your own claim.
2. Tape the evidence cards that support your claim to the Reasoning Tool (in the **Evidence** column). You do not need to use all the cards, but you can use more than one to support your claim.
3. Use the middle column (**This matters because . . .**) to record how the evidence in the left column connects to the claim in the right column.

Organizing Ideas in the Reasoning Tool

Plan how you will use your completed Reasoning Tool to write your argument. Use the example below to guide you.

- Draw a circle around your strongest piece of evidence.
- Draw an X over a piece of evidence if you do not plan to use it in your argument.
- Draw an arrow to connect two pieces of evidence if you think that they go together.



Evidence	This matters because . . . (How does this evidence support the claim?)	Therefore, . . . (claim)
Example Evidence Card A	Your ideas about how the evidence supports the claim	Your claim
Example Evidence Card B	Your ideas about how the evidence supports the claim	
Example Evidence Card C	Your ideas about how the evidence supports the claim	



Writing a Scientific Argument

Write your scientific argument on the next page to the artist at *About Space* magazine. As you write, remember to:

- Review your Reasoning Tool. Be sure to include your strongest piece of evidence and to make a connection between pieces of evidence that go together.
- Use the Scientific Argument Sentence Starters to help you explain your thinking.

Scientific Argument Sentence Starters

<p>Describing evidence:</p> <p>The evidence that supports (or refutes) my claim is . . .</p> <p>My first piece of evidence is . . .</p> <p>Another piece of evidence is . . .</p> <p>This evidence shows that . . .</p>	<p>Explaining how the evidence supports the claim:</p> <p>If ____, then . . .</p> <p>This is important because . . .</p> <p>Since, . . .</p> <p>Based on the evidence, I conclude that . . .</p> <p>This claim is stronger (or weaker) because . . .</p>
--	---

Write a scientific argument that addresses the question: *During a year, will there be a lunar eclipse of the moon of Kepler-47c?*

- First, state your claim.
 - Claim 1:** Yes, there probably will be a lunar eclipse.
 - Claim 2:** No, there probably won't be a lunar eclipse.
- Then, use evidence to support your claim.
- For each piece of evidence you use, explain how it supports your claim.

Name: _____ Date: _____

Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

1. I understand that scientists connect evidence to their claims to make stronger arguments.

yes

not yet

Explain your answer choice.

2. What are the most important things you have learned in this unit about what determines the appearance of the Moon from Earth?

3. What questions do you still have?

Earth, Moon, and Sun Glossary

crescent moon: a moon phase that looks like less than half a circle from Earth

luna creciente: una fase lunar que se ve como menos de la mitad de un círculo desde la Tierra

exomoon: a moon outside our solar system

exoluna: una luna que se encuentra fuera de nuestro sistema solar

exoplanet: a planet outside our solar system

exoplaneta: un planeta que se encuentra fuera de nuestro sistema solar

full moon: a moon phase that looks like a full circle from Earth

luna llena: una fase lunar que se ve como un círculo completo desde la Tierra

gibbous moon: a moon phase that looks like more than half a circle from Earth

luna gibosa: una fase lunar que se ve como más de la mitad de un círculo desde la Tierra

illuminate: to shine light on an object and make it visible

iluminar: arrojar luz sobre un objeto y hacerlo visible

lunar eclipse: when the Moon is completely dark

eclipse lunar: cuando la Luna está completamente oscura

model: an object, diagram, or computer program that helps us understand something by making it simpler or easier to see

modelo: un objeto, diagrama o programa de computadora que nos ayuda a entender algo haciéndolo más simple o fácil de ver

moon: a rocky sphere that travels around a planet

luna: una esfera rocosa que viaja alrededor de un planeta

moon phase: the shape of the illuminated part of the Moon as it appears from Earth

fase lunar: la forma de la parte iluminada de la Luna tal como se ve desde la Tierra

new moon: a moon phase in which the Moon is not visible from Earth

luna nueva: una fase lunar en la que la Luna no es visible desde la Tierra

Earth, Moon, and Sun Glossary (continued)

orbit: the nearly circular path a smaller object (like the Moon) travels around a larger object (like Earth)

órbita: la ruta casi circular por la que un objeto más pequeño (como la Luna) viaja alrededor de un objeto más grande (como la Tierra)

pattern: something we observe to be similar over and over again

patrón: algo que observamos que sea similar una y otra vez

quarter moon: a moon phase that looks like a half-circle from Earth

cuarto de luna: una fase lunar que se ve como la mitad de un círculo desde la Tierra

scale: the relative size of things

escala: el tamaño relativo de las cosas

solar system: the sun, the planets that orbit the sun, and other objects that orbit the sun

sistema solar: el sol, los planetas que orbitan el sol y otros objetos que orbitan el sol

sun: the star that is the main source of light at the center of our solar system

sol: la estrella que es la fuente principal de luz en el centro de nuestro sistema solar

terminator: the border between light and dark on the Moon

terminador: la frontera entre la luz y la oscuridad sobre la Luna

year: the amount of time it takes for a planet to complete one orbit around a star or stars

año: la cantidad de tiempo que tarda un planeta en completar una órbita alrededor de una estrella o estrellas

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