Moon’s Disappearing Act

This unit will introduce students to solar eclipses. Students will develop questions after being introduced to a phenomena. Throughout the unit, students will analyze pieces of evidence to answer their questions and eventually come to understand the sun, earth, moon system.

# STANDARDS ALIGNMENT

**NGSS CONNECTIONS**

**MS-ESS1-1:** Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

**TEKS CONNECTIONS**

**8.7B:** demonstrate and predict the sequence of events in the lunar cycle

# LEARNING OBJECTIVES

**Students will know:**

* Lunar cycle
* Lunar orbital tilt
* Solar eclipses
* Earth’s axial tilt
* Sun-Moon-Earth System

**Students will understand:**

* Why the view of the moon changes night to night
* How solar eclipses occur
* Why solar eclipses occur don’t occur in the same location every eclipse season

**Students will be able to:**

* Use lunar journals to see the pattern of the moon’s visible shape over time
* Use a model of the Earth-sun-moon system to understand the lunar cycle
* Use physical and computer models to understand changes in moon peak times
* Use a model to understand solar eclipses only occur during new moon phases and only when the moon’s orbit passes in front of the sun
* Collect and analyze data about solar eclipses from 2010-2020
* Draw conclusions about the cause of the phenomena and the reason those locations were able to see it

# UNIT PLAN

## Phenomena

Students should be introduced to the phenomena: two days where the moon disappeared from view in the night sky the same day that the sun was briefly blocked causing darkness at noontime. The phenomena have GIFs of the solar incident in addition to the moon imagery preceding and following the solar event. Viewing both phenomena, students are encouraged to ask questions about what is happening and why.

* [What’s Going On?](https://drive.google.com/file/d/1l3YTgsZ37VEeYmw2ghk448O2wFUhUkCE/view?usp=sharing)
* [Phenomena Slides](https://drive.google.com/file/d/17Se2EbFre1Iq8qwZTL0KIranQVi5XdPk/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Phenomena can be provided in parts. First students can view the solar events via projector. Second students can be given the moon images in the form of printouts or viewed on the projector    Students can analyze the provided information on their own, discuss questions in small groups, and share out their questions with the class as a whole. | Phenomena can be shown as a screen share in a presentation or on their own. They can also be provided to students before the session.    If possible, breakout rooms can be used to allow for student discussion of questions that they think of.    Students could also submit questions via a chat window or interactive platform like Pear Deck. | Phenomena can be provided on the school LMS in the form of an assignment or Google Doc.    Students can discuss questions they have via a forum in the LMS or group Google documents. |

Common questions might include:

* Why was the moon not visible the night of the solar incident?
* Why did the moon look like it was disappearing and then come back?
* Did something go in front of the sun, blocking it?
* Does this type of solar event happen often?
* Are the solar and lunar events linked?

Students will be guided through pieces of evidence to help them make sense of the questions they have asked.

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## Evidence

### What caused the moon to disappear and come back?

* Students use collected moon data to analyze two months of moon images. Students analyze the images to recognize patterns. Alternatively, students could complete the moon journal on their own in real time.
  + [Moon Journal](https://drive.google.com/file/d/1hyhKVtNqAqwozovQeRAbUnt1zDSc3Z7R/view?usp=sharing)
* Students use an Earth-sun-moon model to visualize and understand why we see a cyclical lunar pattern. Students are also introduced to moon phase names in a provided video.
  + [Moon Model](https://drive.google.com/file/d/1rrpVuw9RMJLdHMgbNKbFUzb0Qi93yNY3/view?usp=sharing)
    - Students can refer to this [video](https://vimeo.com/502766104) (until 3:08) for help setting up and using their model.
* Students use their Earth-sun-moon model to make predictions about why the moon is visible at different times of the day and night. Students then use a computer model to collect data and test their hypothesis.
  + [The Best Time to See the Moon](https://drive.google.com/file/d/1yTI810V0LkfGnJCTKo0Iy8x9Oo5PqgaZ/view?usp=sharing)
    - Students can refer to this [video](https://vimeo.com/502766104) (3:08-6:03) for help setting up and using their model.

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| In classroom | Synchronous online | Asynchronous online |
| Students, if able, can complete at least 1 month of the moon journal on their own as homework. Using the provided online data, can be used if the moon journal cannot be completed in that timeline.  Instructor can set up a light source at the center of the room and have students surround the light. Instructor can walk students through the directions as a group.  Instructor can use this same setup to walk through the beginning of the Best Time to See the Moon. Guiding questions should be used to help students understand what is visible from Earth when they are in their positions.  Students can work in pairs on computers to use the computer model to collect data and then complete the associated questions. The class should debrief these answers as a group. | Students, if able, can complete at least 1 month of the moon journal on their own as homework.  Using the provided online data in asynchronous time, can be done if the moon journal cannot be completed in that timeline.  Instructor should review how to set up the Earth-sun-moon model with students and walk through the first few steps before having students complete the worksheet in asynchronous time. The activity could also be done synchronously if the instructor has a setup that allows students to view the relationship of the parts of the system (ideally a wide view of the full earth-sun-moon system, and a closer angle with the view of the moon from earth)  Instructor should review how to set up the Earth-sun-moon model with students and walk through the first few steps before having students complete the worksheet asynchronously. Alternatively could be demoed by the instructor.  The computer model should be introduced to students via screen share to review its parts. Students should then be split into pairs or small groups in break out rooms to collect data together. The data could be split up between groups (each collecting data for a specific phase in the table). Students should work in their small group to complete the Phenomena question before discussing as a class. | Students, if able, can complete at least 1 month of the moon journal on their own as homework.  Using the provided online data can be done if the moon journal cannot be completed in that timeline.  Students can set up their model and can submit photos of their set up or their view of the moon from different positions.  Students can use the panorama feature on their phone to help them determine the time of day in the first part. Students should only take a picture from their left shoulder to their right shoulder. The position of the sun in their photo should help to identify the time of day.  The data collection for the Time to See the Moon could be split up between students (each collecting data for a specific phase in the table). Students should work in their small group to complete the table and then the following Phenomena question before discussing as a class. |

### What caused the weird event in the middle of the day?

* Students use their Earth-sun-moon model to show a solar eclipse and watch videos to learn more about the information scientists gather from these events.
  + [Introduction to Solar Eclipses](https://drive.google.com/file/d/12vrjV-92ZuWJ7HOunBLyl4QAZt-mLojg/view?usp=sharing)
    - Students can refer to this [video](https://vimeo.com/502766104) (6:03-7:15) for help setting up and using their model.
* Students modify their Earth-sun-moon model to account for the moon’s orbital angle in addition to the earth’s revolution around the sun to understand the frequency of solar eclipses.
  + [A Solar Eclipse Every Month?](https://drive.google.com/file/d/19YFt6fDVd8zaJwB6OeBthUyOxKQuJgw4/view?usp=sharing)
    - Students can refer to this [video](https://vimeo.com/502766104) (7:15-end) for help setting up and using their model.

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| In classroom | Synchronous online | Asynchronous online |
| Instructor can set up a light source at the center of the room and have students surround the light. Instructor can walk students through the directions as a group.  Videos can be viewed via projector and answers can be discussed as a class.  The model set up can be used as a class as well. A station set up is ideal (each station a different point along the earth’s orbit). Instructors should demonstrate the moon’s orbital angle and how it stays the same even as the earth rotates and revolves.  Students can work in pairs to help one student to be earth and look for what is visible and the other can be in charge of the placement of the moon around the Earth. | Instructor should review how to set up the Earth-sun-moon model with students and walk through the first few steps before having students complete the worksheet in asynchronous time. The activity could also be done synchronously if the instructor has a setup that allows students to view the relationship of the parts of the system (ideally a wide view of the full earth-sun-moon system, and a closer angle with the view of the moon from earth)  Videos can be watched asynchronously or synchronously via screen share. The questions accompanying can be used in polling platforms or quiz formats.  Instructor can review the modifications to the model for students to use asynchronously. A review of student conclusions after with the class is recommended. | Students can set up their model and can submit photos of their set up or their view of the moon from different positions. |

### Why were these similar events viewed in different places at different times?

* Students use NASA solar eclipse data to see where previous eclipses have been visible to see the pattern of eclipses in the northern and southern hemispheres.
  + [Patterns in Ecliptic Data](https://drive.google.com/file/d/1h85tD37FDqpiMVhznd9d25-hpHJNqkc9/view?usp=sharing)
* Students will use a 3D solar compass to see the sun’s path in different locations to learn that the Earth’s axis is tilted.
  + [How Eclipse Locations Change](https://drive.google.com/file/d/1psvhlWc-RYjjDOkzoCBkDszEYEF43DLt/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work individually or in pairs to collect data for the pattern in ecliptic data. Alternatively, students or groups of students could be given specific dates to investigate and collect all of the information on a class shared document.  A class discussion can take place to share ideas about patterns found.  Students can work individually or in pairs to complete How eclipse locations change. One student could investigate Chile and the other Idaho and then share data. The video can be viewed via projector.  Students should play with the Earth-sun-moon interactive model on their own, but an instructor should display this model via projector to pause and slow down the model to show the differences in eclipses when the axial tilt changes. | Students can work individually or in pairs to collect data for the pattern in ecliptic data. Alternatively, students or groups of students could be given specific dates to investigate and collect all of the information on a class shared document.  Polling software can be used to collect patterns noticed from the data.  Students can work individually or in pairs to complete How eclipse locations change. One student could investigate Chile and the other Idaho and then share data. The video can be viewed via screen share.  Students should play with the Earth-sun-moon interactive model on their own, but an instructor should display this model via screenshare to pause and slow down the model to show the differences in eclipses when the axial tilt changes. | Students can work individually on the worksheet or can be given specific dates to investigate and collect all of the information on a class shared document.  Students can work individually or in pairs to complete How eclipse locations change. One student could investigate Chile and the other Idaho and then share data in a shared google document.  Students should play with the Earth-sun-moon interactive model on their own, but an instructor should display this model via recorded video to pause and slow down the model to show the differences in eclipses when the axial tilt changes. |

## Conclusions

* Students construct a claim backed up by evidence and reasoning to answer the following question:
  + [Why did the sun disappear briefly from Chile’s sky in February 2017 and from Idaho’s sky in August 2017?](https://drive.google.com/file/d/1Vq_iTtMwfmGhmp8qpqmbuNw6lB_ZB227/view?usp=sharing)

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| In classroom | Synchronous online | Asynchronous online |
| Students can work on this individually, then in pairs or small groups.    Groups should present their argument to the other groups and students should provide feedback on the presented argument. | Students can work on this individually, then in pairs or small groups via a shared Google Doc. This should be done before the synchronous session.    Groups should present their argument to the other groups and students should provide feedback on the presented argument.    As a class, ask students to answer the question again via a platform like a chat window or Pear Deck. | Students can work on this individually, then in pairs or small groups via a shared Google Doc.    Groups should create a document (Google Doc, Slides, or video) of their argument to be shared with other classmates. Classmates will review the argument and provide feedback.    As a class, ask students to answer the question again via Google Quiz or LMS forum. |

**Additional resources**

* [Blood Moon Article](https://drive.google.com/file/d/1FcQ0nQtqMy0jznDr9PMFwDd8yKNsoozu/view?usp=sharing)
* [Moon Phases Article](https://drive.google.com/file/d/1gQcqlTHKwz5mbBSe5AhghLc89QUrfCMk/view?usp=sharing)
* [Printable Moon Phases Game](https://drive.google.com/file/d/1X0irr5w4ko22s-evCEL9dHg-qkleF6xJ/view?usp=sharing) and [Instructions](https://drive.google.com/file/d/1S78hV3_undmUPzpue_CWxtChSRZvUVDt/view?usp=sharing)
* [PurposeGames’ Moon Phases (from space)](https://www.purposegames.com/game/1016)
* [Moon Match Game](https://teachers.henrico.k12.va.us/staffdev/clough_d/DragDrop/MoonMatch.html)