Science Objectives

- Students will identify patterns in data associated with the lunar phases.
- Students will describe how the relative positions of the Earth, the Moon, and the Sun cause lunar phases.
- Students will identify why a graph of illumination of the Moon during the lunar cycle is a function.
- Students will describe the requirements for an eclipse.

Vocabulary

- illumination
- phase
- eclipse
- percent error

About the Lesson

- In this lesson, students will study the cycle of lunar phases.
- As a result, students will:
  - Estimate the portion of the Moon's surface that is illuminated each day of the lunar cycle.
  - Identify patterns in data that is presented in a table and in a graph.
  - Use interactive animations to investigate the relative positions of Earth, the Moon, and the Sun during each phase and the requirements for an eclipse to occur.

TI-Nspire™ Navigator™

- Send out the .tns file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.
- Enter items as appropriate for use of TI-Navigator.

Activity Materials

- *Its_Just_a_Lunar_Phase*.tns document
- *The_Lunar_Cycle* document
- TI-Nspire™ Technology

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Enter data in a spreadsheet
- Control an animation

Tech Tips:

Make sure that participants understand how to control an animation using  ,  , and  .

Lesson Materials:

Student Activity

- Its_Just_a_Lunar_Phase_Student.doc
- Its_Just_a_Lunar_Phase_Student.pdf

TI-Nspire document

- Its_Just_a_Lunar_Phase.tns

Discussion Points and Possible Answers

Allow students to read the background information on the student activity sheet.

Move to page 1.2.

1. Have students read the background on page 1.2, and then examine the images on the handout titled "The Lunar Cycle." For each day, they need to estimate and record the percentage of the Moon that is illuminated. Then have them write their percentages as decimals filling in the missing data as shown in the following table:

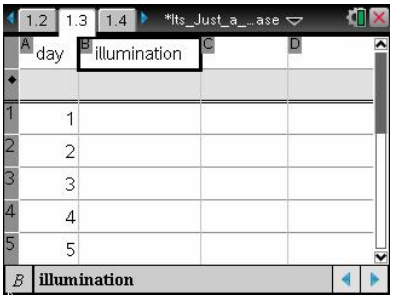
Sample Answers:

Day	Illumination		Day	Illumination		Day	Illumination		Day	Illumination	
1	1%	0.01	**8**	**61%**	**0.61**	**15**	**99%**	**0.99**	**22**	39%	0.39
2	**5%**	**0.05**	**9**	72%	0.72	**16**	95%	0.95	**23**	**29%**	**0.29**
3	**11%**	**0.11**	**10**	**81%**	**0.81**	**17**	**89%**	**0.89**	**24**	24%	0.24
4	19%	0.19	**11**	89%	0.89	**18**	82%	0.82	**25**	**18%**	**0.18**
5	**28%**	**0.28**	**12**	**95%**	**0.95**	**19**	**71%**	**0.71**	**26**	**11%**	**0.11**
6	39%	0.39	**13**	98%	0.98	**20**	62%	0.62	**27**	5%	0.05
7	**50%**	**0.50**	**14**	**100%**	**1.00**	**21**	**50%**	**0.50**	**28**	**0.2%**	**0.002**

Teacher Note: The above given rounded "actual" values are from the graph on page 1.7 of the .tns file. Students' "estimated" values should vary and may not even be close from guessing visually. This is ok, because they will use their estimates later to find the percent error.

Move to page 1.3.

2. Have students enter their illumination data (as decimals) into the spreadsheet, and then, answer question 1 on the activity sheet.

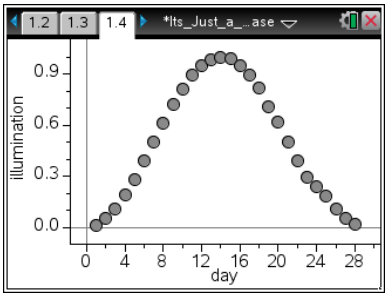


Q1. What general patterns do you see in the table or spreadsheet?

Answer: The illumination begins at nearly zero and gradually increases for 14 days before gradually decreasing.

Move to page 1.4.

3. The data in their spreadsheet is plotted on the graph. The d*ay* is the independent variable, or a variable that isn't changed by another, and *illumination* is the dependent variable, a variable that does change based on another.



   Have students answer question 2 on their activity sheet.

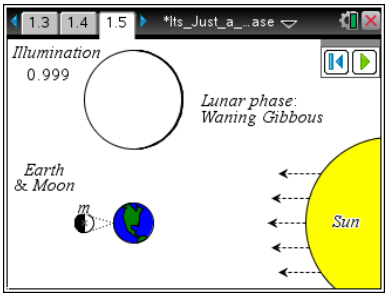
Q2 How does the graph change your ability to spot a pattern?

Answer: It is easier to see the increase and decrease of the data on the graph than it is in the table.

Move to page 1.5.

Students can view the animation or move the Moon to a position in its orbit. The visual of the Moon, its illumination, and the current phase all update as the Moon's position changes. This view is from above the plane of the ecliptic. Have students answer question 3 on their activity sheet.

4. Page 1.5 shows the illuminated portion of the Moon, along with its position relative to the Earth and the Sun. Students can change the Moon's position by dragging point *m*, which is indicated by an "**×**" in the center. The play button starts the animation, moving the Moon around Earth. Students are to observe the position of the Moon, the Sun, and Earth at different **phases**. They can click to pause and click to reset. Then have students answer question 3 on the activity sheet.

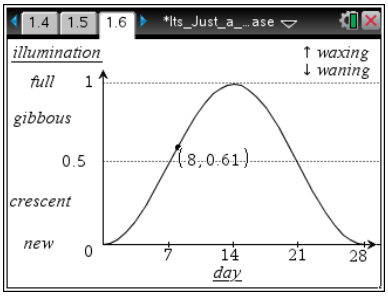


Q3. How does the Moon's location around Earth affect its phase?

Answer: Starting from a new moon, as the Moon moves around Earth, the amount of illumination increases and reaches a full moon once Earth is directly in between the Moon and the Sun. As the Moon continues around Earth, the illumination decreases until the next new moon.

Move to page 1.6.

5. Page 1.6 contains a graph of an actual lunar cycle. When taking a measurement, there may be a difference between a measured value and an actual or accepted value. **Percent error** is a measure of how close the values are. It is calculated using the following equation:



$$\text{percent error} = \frac{|\text{estimated value} - \text{actual value}|}{\text{actual value}} \times 100$$

Since only estimates were done in step 1, then the measured value will be called the estimated. Have students answer question 4 on their activity sheet.

> **Teacher Tip:** You may need to also explain to students that the vertical bars on the top of the fraction represent finding the absolute value.

Q4. Choose a day, (not a given one), from the table completed in Step 1, on page 1.3 of the tns file, and record your estimated illumination below. On the graph, click on the Day value (*x*-value) inside the ordered pair and re-type the whole number day you have chosen. Record the *y*-value, or the second value in the ordered pair, of the point as the actual illumination. Use the Scratchpad to calculate percent error.

> **Teacher Tech Tip:** Having students click on the Day value (*x*-value) inside the ordered pair and **re-type the whole number day** they have chosen will be easier than trying to drag the point to a whole number day value.

Day: _____ Estimated illumination: _____ Actual illumination: _____

Percent error: $= \frac{\left|\square - \square\right|}{\square} \times 100 =$ _____

Sample Answers:

Day: 5 Estimated illumination: 0.25 Actual illumination: 0.282

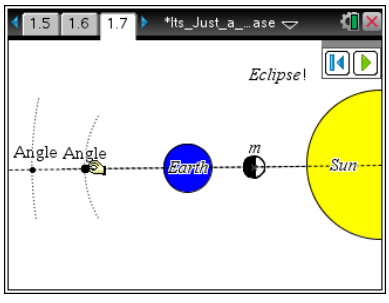
Percent error $= \frac{\left|0.25 - 0.282\right|}{0.282} \times 100 =$ 11.3%

Move to page 1.7.

Students can change the angle of the Moon's orbit and of the Earth's orbit. Have students select angles and run the animation to determine if an eclipse occurs. Only when the planes of the orbits coincide will eclipses happen. Have students answer question 5 on the activity sheet.

6. A common question is, "Why doesn't every new moon and full moon result in an eclipse?"

   Page 1.7 illustrates the orbital angles of the Moon and Earth. To change these angles, drag the points labeled "Angle." Change the Moon's position by dragging point *m* or using the animation controls.



Q5. What are the requirements of the orbital angles of the Moon and Earth for an eclipse to happen?

Answer: The angle of the Moon's orbit and of Earth's orbit must be the same so that the Moon, Earth, and the Sun are in a straight line.

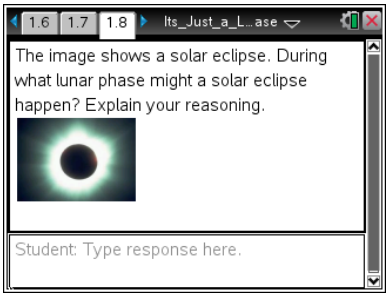
TI-Nspire Navigator Opportunities

Make a student a Live Presenter to illustrate the requirements of an eclipse. Perform a quick poll to determine the number of students who have observed a solar eclipse and the number of students who have observed a lunar eclipse.

Move to page 1.8.

Have students answer question 6 on either the handheld, on the activity sheet, or both.

7. The lunar phase determines whether a solar eclipse or a lunar eclipse might happen.



Q6. The image shows a solar eclipse. During what lunar phase might a solar eclipse happen? Explain your reasoning.

Answer: A solar eclipse might happen during a new moon. The Moon comes between the Sun and Earth during a solar eclipse, which is the position needed for a new moon.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.