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

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

- **Tech Tips:** This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

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:

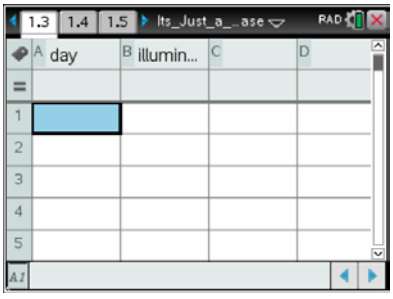
Sample Answers:

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 (%) into the spreadsheet, and then, answer question 1 on the activity sheet.

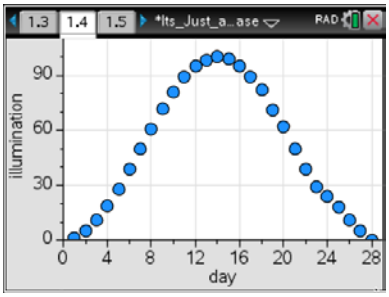


Q1. What general patterns do you see in the table or spreadsheet?

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.

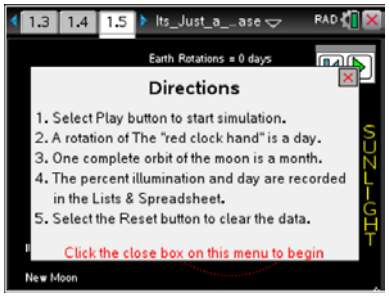
Q2 How does the graph change your ability to spot a pattern?

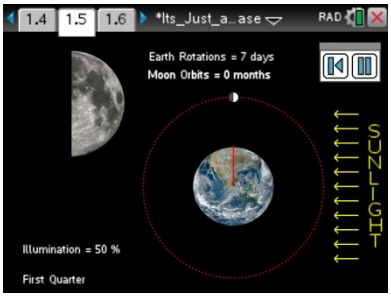
Answer: It is easier to see the increase and decrease of the data on the graph than it is in the table.

Move to page 1.5.

Students can view the animation and observe as the visual of the Moon, its illumination, and the current phase all update as the Moon's position changes. Have students answer question 3 on their activity sheet, after they view the simulation.

4. Page 1.5 shows the illuminated portion of the Moon, along with its position relative to Earth and the Sun. Run the simulation to observe the position of the Moon, the Sun, and Earth at different **phases**. The play button starts the animation, moving the Moon around Earth. They can click to pause and click to reset. Then have students answer question 3 on the activity sheet.



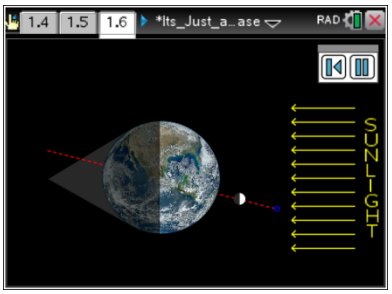


Q3. How does the Moon's location around Earth affect its phase?

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.

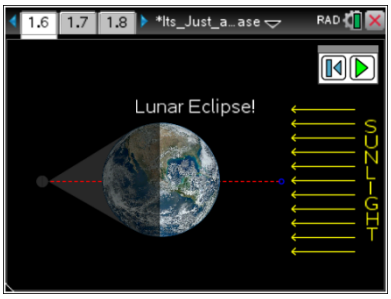
Move to page 1.6.

4. Using the simulation, try to discover when a lunar eclipse occurs! You can grab and drag the blue point to adjust the incline of the moon's orbit. One complete orbit of the moon is a month. You can click the play button to start the simulation, and pause it as well.



Q4. What are the requirements of the orbital angles of the Moon and Earth for an eclipse to happen?

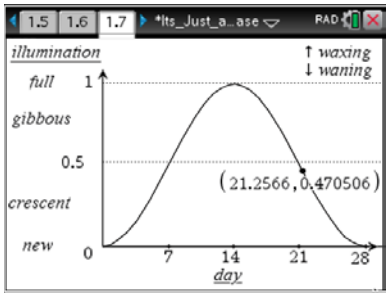
Answer: The angle of the Moon's orbit and of Earth's orbit must be the same so that the Moon, Earth, and the Sun are in a straight line.



Move to page 1.7.

5. Page 1.7 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:

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

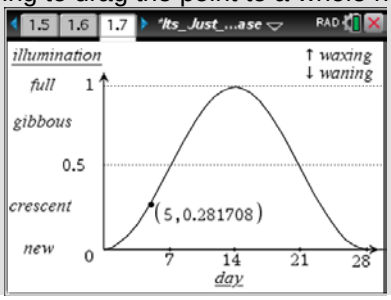


Since only estimates were done in step 1, then the measured value from page 1.7 will be called the actual value. Have students answer question 5 on their activity sheet. They should use the decimal value for the estimated value from the data table they completed in #1.

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, (one that was calculated), from the table completed in Step 1, ~~on page 1.3 of the tns file~~, and record your estimated illumination below in decimal form. On the graph on page 1.7, 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: 0.28 Actual illumination: 0.282

Percent error $= \frac{|.28-.282|}{.282} \times 100 =$ .7%

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.

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.