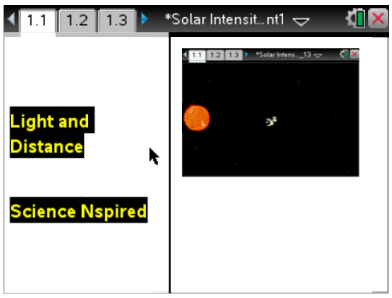
Science Objectives

- Students will investigate and discover relationships between light and distance.
- Students will use a mathematical formula to determine a celestial body's unknown distance to the Sun.
- Students will recognize the large distances between objects in our solar system.



Vocabulary

- astronomical unit
- celestial body
- light intensity
- inverse

About the Lesson

- As a result of this lesson, students will:
  - Understand how to determine the distance of an object from the Sun by measuring the light intensity at the surface of the object.
  - Calculate an object's location using the inverse square law.

TI-Nspire™ Navigator™

- Send out the *Light_and_Distance.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

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

- Light_and_Distance_Student.doc
- Light_and_Distance_Student.pdf

TI-Nspire document

- Light_and_Distance.tns

Discussion Points and Possible Answers

Have students read the background information stated on their activity sheet or page 1.2 of the .tns file.

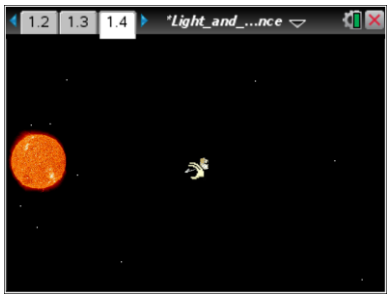
Move to page 1.3

Have students answer question 1 in the .tns file, activity sheet, or both.

Q1. 1 AU is the distance between what two celestial bodies?

Answer: C. the Sun and the Earth

Move to page 1.4.



1. Students will move the cursor over the left side of the probe that appears on the screen. When a hand appears, they should select and drag the probe across the dots on the screen. The dots are "hotspots" that represent objects in the solar system.

2. Students will select each hotspot on the screen. When they do this, a box will appear displaying the name of the object, the light intensity at the object's location, and the distance of the object from the Sun.

3. There are 2 unknown objects to discover in addition to the 8 planets. The distance of each celestial body from the Sun as well as the light intensity data will be captured on the spreadsheet on page 1.5. It will also be graphed on page 1.6. If students select menu **> Light and Distance > Erase data** page 1.4, the data will be cleared from the spreadsheet and the graph.

Tech Tip: To access the Directions again, select **> Light and Distance > Directions..**

Tech Tip: To access the Directions again, select menu or **Document Tools ( ) > Light and Distance > Directions.**

Move to pages 1.5 - 1.6.

Have students copy their data down onto the student worksheet.

Tech Tip: To scroll through data in the spreadsheet on screen 1.5, students can press their finger anywhere on the screen and drag it up or down.

Celestial Body	Distance (AU)	Light Intensity
Mercury	0.387	6.6769
Venus	0.723	1.913
Earth	1.	1.
Mars	1.524	0.431
Jupiter	5.203	0.0369
Saturn	9.539	0.01098
Uranus	19.189	0.0027
Neptune	30.06	0.0011066
Asteroid	?	.092
Comet	?	.002

Move to pages 1.7 - 1.10.

Have students answer questions 2-5 in the .tns file, the activity sheet, or both.

Q2. As the objects get further away from the sun, what happens to the intensity of the sunlight at the surface of the object?

Answer: B. The light intensity decreases.

Q3. While Earth is 1 AU away from the sun, Venus is only .723 AU away. Knowing this, how does the intensity of light on Venus compare with the intensity of light on Earth?

Answer: C. The sunlight on Venus is more intense than it is on Earth.

Q4. On page 1.6, a line graph is displayed showing the data. If you have not done so already, set the *y*-axis to distance and the *x*-axis to intensity. A linear graph is a straight line which is often used to show a series of consistent data points. Is the graph linear on page 1.6? (Ignore the two objects located at distance zero. These are the objects with unknown distance.)

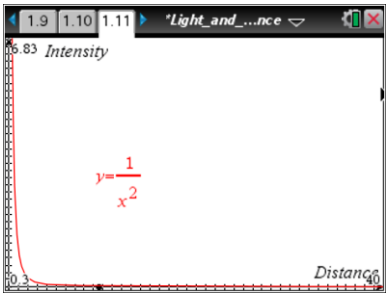
Answer: B. No.

Q5. Explain your reasoning for the question you just answered on the previous page 1.9.

Sample Answer: Student answers will vary. The curve is an exponential shape; specifically, it shows an inverse square relationship.

Move to page 1.11.

3. On page 1.11, a graph will appear with an equation representing the inverse square law. Students will be asked to use this equation to determine the distance their unknown objects are from the sun. Students should take a moment to reflect and compare this graph to the graph on page 1.6.



Move to pages 1.12 - 1.15.

Have students answer questions 6 - 9 on the device, the activity sheet, or both.

Q6. How does the graph on page 1.11 compare to the graph on page 1.6?

Sample Answer: Both graphs are identical.

Q7. What equation is used on the graph located on page 1.11?

Sample Answer: $y = 1/x^2$.

Q8. What does *x* represent in the equation on page 1.11?

Answer: A. distance

Q9. Which of the following best describes the relationship between the intensity of light and the distance of an object from the light source?

Answer: A. The intensity changes according to the inverse square of the distance.

Move to pages 1.16 – 1.18.

On page 1.16, the equation from page 1.11 is solved for *x:*

$$x = \sqrt{\left(\frac{1}{y}\right)}$$

where *x* is the distance of an object from the light source and *y* is the light intensity on the surface of the object.

Q10. Find the asteroid on page 1.4. Using the formula on page 1.16, calculate the distance of the asteroid from the sun. *Express your answer in units of AU. Use up to 4 decimal points in your answer and only include numbers, no letters in your response.*

Answer: 3.2969

Q11. Find the comet on page 1.4 of your simulation. Using the formula on page 1.16, calculate the distance of the comet from the sun. *Express your answer in units of AU. Use up to 4 decimal points in your answer and only include numbers, no letters in your response.*

Answer: 22.3607

Move to page 1.19.

4. After answering all of the questions in the simulation, students should go back to the lists and spreadsheets page 1.5 and enter the distances they calculated for the asteroid and the comet. Students should then compare the curve on page 1.6 with the curve on page 1.11. If the curve on page 1.6 resembles the curve on page 1.11, then the student has calculated the distances in questions 10 and 11 correctly. However, if the curves do not resemble one another, the students should then go back and recalculate their distances for the asteroid and comet.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to illustrate show how to move the probe around the screen. Throughout the activity, monitor student progress. At the end of the activity, collect the .tns file and save to Portfolio.

Wrap Up

When students are finished with the activity, retrieve 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 could consist of questions/problems on the chapter test or an assessment where you give students a series of unknown distances/light intensities and they have to solve for the missing variable.