Science Objectives

- Students will observe the affect of moving an object toward and away from a concave mirror.
- Students will graph the relationship between the object distance and the image distance from a mirror's focal point.
- Student will create an equation relating object distance to image distance.

Vocabulary

- concave
- focal point
- image
- mirror
- virtual image

About the Lesson

- Students will manipulate an object about a focal point while observing the image that is produced.
- As a result, students will:
  - Understand that the size of the image and the distance of the image from the mirror is inversely proportional to the distance of the object from the focal point.
  - Determine a relationship between object distance, image distance and focal length.

TI-Nspire™ Navigator™

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

Activity Materials

- *Concave_Mirrors.tns* document
- TI-Nspire™ Technology

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and move points
- Capturing data in a spreadsheet

Tech Tips:

Students need to know how to grab and move points. If there are two moveable points they can use tab to switch between points.

Students can manually capture data by pressing ctrl . while on a graph to populate a spreadsheet.

Lesson Materials:

Student Activity

- Concave_Mirrors _Student.doc
- Concave_Mirrors _Student.pdf

TI-Nspire document

- Concave_Mirrors.tns

Visit www.sciencenspired.com for lesson updates and tech tip videos.

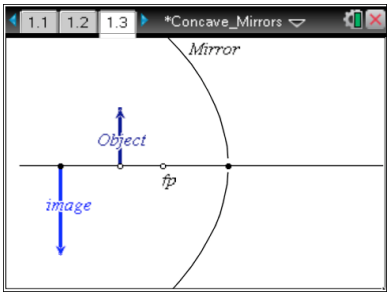
Discussion Points and Possible Answers

Move to page 1.2

1. Students should read the instructions for the simulation.

Move to page 1.3.

2. Students will grab the base of the object arrow and move it slowly toward the mirror. They will notice that the image quickly moves off the screen to the left.



Move to pages 1.4–1.10.

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

Q1. Describe the image formed when the object is farther than the focal point (**fp**) is from the mirror.

Answer: The image is inverted and on the same side of mirror.

Q2. Describe the image formed when the object is between the focal point and the concave mirror.

Answer: The image is virtual and upright on the opposite side of the mirror.

Q3. What are the relative positions of the focal point, object, and mirror when the image formed by a concave mirror is a real image?

Answer: The image is real when the object is not between the focal point and mirror.

Q4. What are the relative positions of the focal point, object, and mirror when the image formed by a concave mirror is a virtual image?

Answer: The image is virtual when the object is between the focal point and the mirror.

Q5. What are relative positions of the focal point, object, and mirror when the image is smaller than the object?

Answer: The image is smaller when formed between the object and the focal point and the object is more than 2 focal lengths from the mirror.

Q6. What are the relative positions of the focal point, object, and mirror when the image is the same size as the object?

Answer: when the object is 2 focal lengths from the mirror

Q7. What are the relative positions of the focal point, object, and mirror when the image formed by a concave mirror is larger than the object?

Answer: when the object is between 2 focal lengths from the mirror and 1 focal length

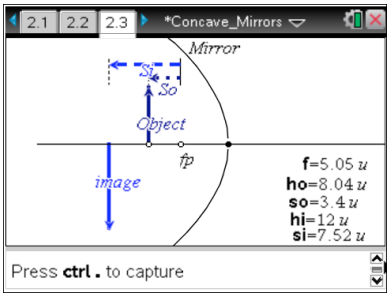
Tech Tip: To reset the columns in a spreadsheet, highlight the diamond cell (equation cell) and press enter.

Move to pages 2.1 and 2.2.

3. The students will read the instructions to prepare for the simulation on page 2.3. The simulation displays the distance to the focal point (**f**), the height of the object ($\mathbf{H_o}$), the distance between the object and the focal point ($\mathbf{S_o}$), the height of the image ($\mathbf{H_i}$), and the distance between the image and the focal point ($\mathbf{S_i}$).

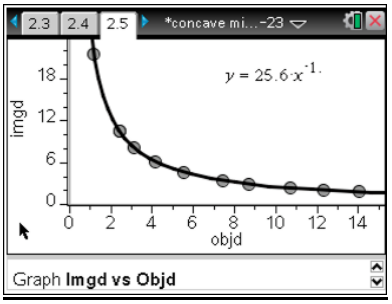
Move to page 2.3.

4. The students will move the object by dragging the bottom point. They will press ctrl . to capture the values for **f**, $\mathbf{H_o}$, $\mathbf{S_o}$, $\mathbf{H_i}$ and $\mathbf{S_i}$. The student will continue to move the Object and capture data. The students will make sure to capture some data between the focal point and the mirror. They will collect data for 10 to 15 locations of the Object.



Move to pages 2.4 and 2.5.

5. The students select the variables **lmgd** and **objd** in columns A and B of the spreadsheet and then graph the image distance (**lmgd**) vs. the object distance (**objd**). A sample graph is shown to the right.



Move to pages 2.6 and 2.7.

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

Q8. Describe the relationship between the object distance (**objd**) and image distance (**imgd**) ($\mathbf{S_O}$ and $\mathbf{S_i}$).

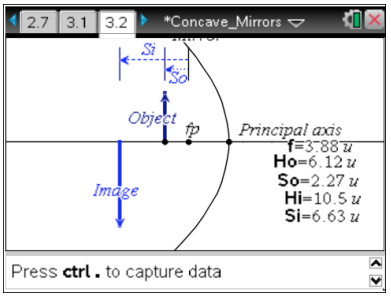
Answer: The object distance and the image distance are inversely proportional.

Q9. Write the equation for the curve that best fits your data.

Answer: $y = 25.6*x^{-1}$ or $S_i = f^2/S_o$ (Answer may vary if students changed **fp**.)

Move to pages 3.1–3.4.

6. The students will adjust the focal length of the mirror by moving point **fp** to a new location. They will try your best to get it very near a whole number. The students will adjust the Object and capture the data again. They will find the best fit equation for the data after it is generated.
7. The students will graph image distance (**imgd**) vs. object distance (**objd**).



Move to pages 3.5 and 3.6.

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

Q10. How is the focal point represented in the equation generated for the graph?

Answer: The focal point distance is the square root of the constant

Q11. Write the equation that fits your new data set in terms of $\mathbf{S_o}$, $\mathbf{S_i}$ and **f**.

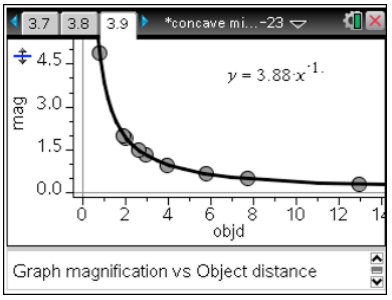
Answer: $S_i = f^2/S_o$ or $S_i = f^2 * S_o^{-1}$

Move to pages 3.7–3.10.

The students will read that the magnification of an object is the ratio of the image height to the object height:

H_i/H_o = Magnification

8. On page 3.9, the students will use column F to calculate the magnification of each data point collected. They will assign this column to the variable **mag**. Then the students will make a graph of magnification (**mag**) vs. object distance (**objd**) on page 3.10.



Move to pages 3.11–3.13.

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

Tech Tip: Students will need to title a column **mag** and enter an equation in the diamond cell below the title and type **=imgh/objh**.

Q12. How is magnification affected by the Object's distance from the focal point?

Answer: The further the object is from the focal point and mirror the smaller the magnification.

Q13. What is the equation for the best fit curve for magnification vs. object distance?

Answer: $y = 3.88 * x10^{-1}$ or HI=f/So. (Answers may vary if students changed **fp**.)

Q14. How does changing the position of the focal point affect the magnification?

Answer: The constant in the image height equation is equal to the focal distance.

TI-Nspire Navigator Opportunities

Use Navigator to capture screen shots of student progress and to retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolio.

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.