EXPLORATIONS

Activity 14

The Closer I Get to You

Objectives

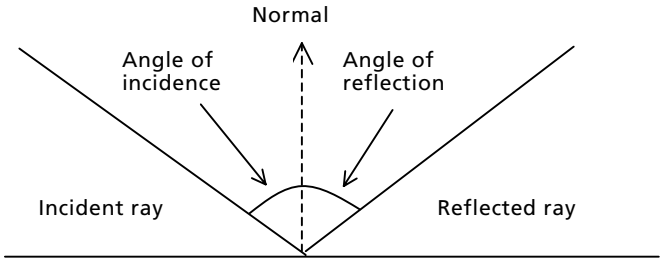
- To find a rational function
- To find the *x* value of a function, given the *y* value
- To find the *y* value of a function, given the *x* value
- To use technology to plot data

Materials

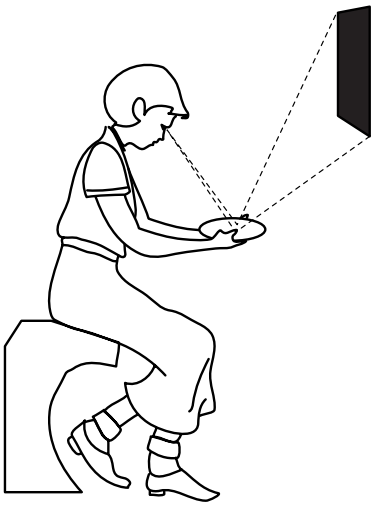
- TI-73 graphing device
- Small mirror (one per group)
- Adding machine paper (at least 500 cm per group)
- Masking tape and markers
- Meter stick (one per group)

Introduction

If you drop a ball on the ground, it will return to you along the same path in which it was released. If you throw the ball so that it hits the floor at an angle, the ball will return in the opposite direction, keeping the same angle with the floor. Light follows a similar pattern. When light rays strike a surface, the ray that strikes the surface is called the *incident ray*, and the ray that is reflected is called the *reflected ray*. The law that describes this phenomenon is called the *Law of Reflection*. This law states that the angle of incidence is equal to the angle of reflection. (See diagram below.)



To explore the *Law of Reflection*, hold a mirror in the palm of your hand parallel to the ground and at a level that allows you to look into the mirror (see diagram on the next page). Find an object or classmate that is above your eye level (for example, a poster on the wall, a word on the blackboard, or a person in the room). Walk away from the object and observe what happens as you look in the mirror. Walk towards the object and observe what happens as you look in the mirror. Your discovery might lead you to an interesting observation that can be used to find the height of an object.

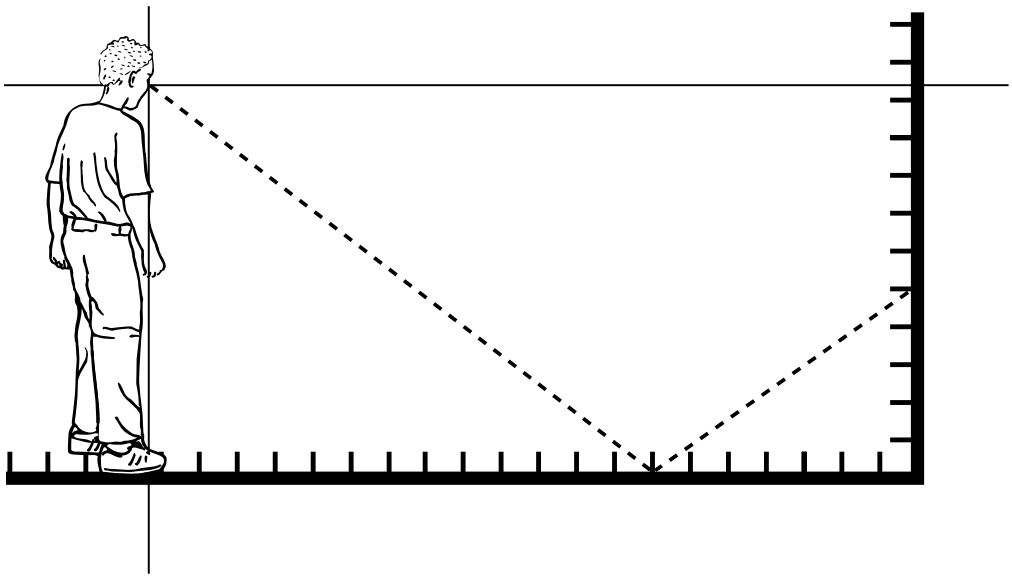


Problem

How can you use the *Law of Reflection* to find the height of objects that are impractical to measure using conventional techniques? Can you use a mirror to find the height of a classmate?

Collecting the data

1. Obtain two pieces of adding machine paper from your teacher. One should be slightly longer than one meter in length, and the second should be about four meters in length. Mark 0 (zero) at one end of each strip of paper. (Write the number at least 3 centimeters tall.) Measure, mark and label each strip every 10 centimeters, starting at zero, until you reach the end of each strip of paper.
2. Tape the 1-meter paper strip to the wall, making sure 0 is positioned on the floor.
3. Tape the 4-meter paper strip on the floor, with 0 in the same position as the paper strip on the wall. Make sure this strip is perpendicular to the wall.
4. Obtain a mirror from the teacher. Using a washable marker, draw a 2 cm x 2 cm square in the center of the mirror. Place the mirror on the paper on the floor at the 20 cm mark. The square should be centered on the 20 cm mark.
5. Select one of the group members to be the spotter, one as the marker, and one as the scribe. Measure the *eye-level* height in centimeters of the spotter.
6. Instruct the spotter to face the paper strip on the wall. Ask the spotter to move away from the wall until the reflection of the numeral 10 can be seen in the mirror. Mark the position of the spotter's toe on the paper strip on the floor. Record this position in the table on the **Data Collection and Analysis** page. (See diagram that follows.)



7. Ask the spotter to walk slowly towards the paper strip on the wall until the reflection of the numeral 20 can be seen in the mirror. Mark the position of the spotter's toe on the paper strip on the floor. Record this position in the table on the **Data Collection and Analysis** page.

   Note: *The spotter's distance from the wall is the only variable that changes.*

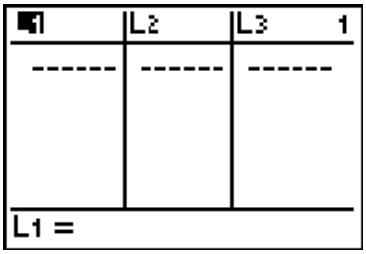
8. Continue this procedure until the spotter has seen the reflection of all the numerals on the paper strip.

Setting up the TI-73

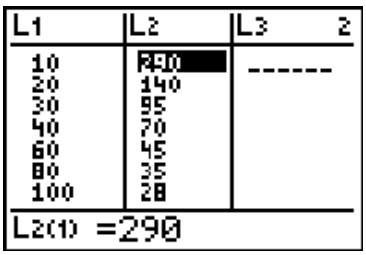
Before starting your data collection, make sure that the TI-73 has the STAT PLOTS turned OFF, Y= functions turned OFF or cleared, the MODE and FORMAT set to their defaults, and the lists cleared. See the Appendix for a detailed description of the general setup steps.

Entering the data in the TI-73

1. Press LIST.

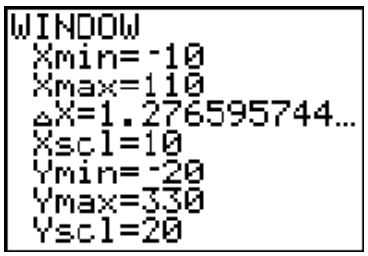


2. Enter the data for the height on the wall in **L1**.
3. Enter the data for the distance from the wall in **L2**.



Setting up the window

1. Press [WINDOW] to set up the proper scale for the axes.
2. Set the **Xmin** value by identifying the minimum value in **L1**. Choose a number that is less than the minimum.

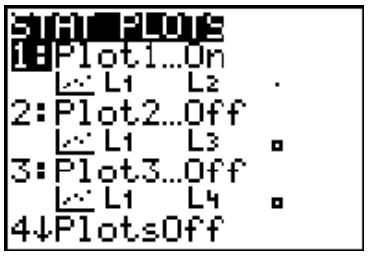


3. Set the **Xmax** value by identifying the maximum value in each list. Choose a number that is greater than the maximum. **Do Not Change the ΔX Value.** Set the **Xscl** to **10**.
4. Set the **Ymin** value by identifying the minimum value in **L2**. Choose a number that is less than the minimum.
5. Set the **Ymax** value by identifying the maximum value in **L2**. Choose a number that is greater than the maximum. Set the **Yscl** to **20**.

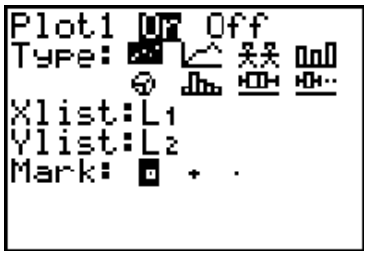
Graphing the data: Setting up a scatter plot

Plot a scatter plot using the data in the table on the **Data Collection and Analysis** page.

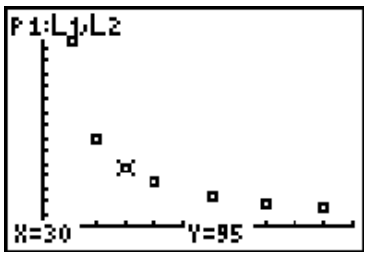
1. Press [2nd] [PLOT]. Select **1:Plot1** by pressing **1** or [ENTER].



2. Set up the plot as shown by pressing [ENTER] [▼] [ENTER] [▼] [2nd] [STAT] **1:L1** [▼] [2nd] [STAT] **2:L2** [▼] [ENTER].

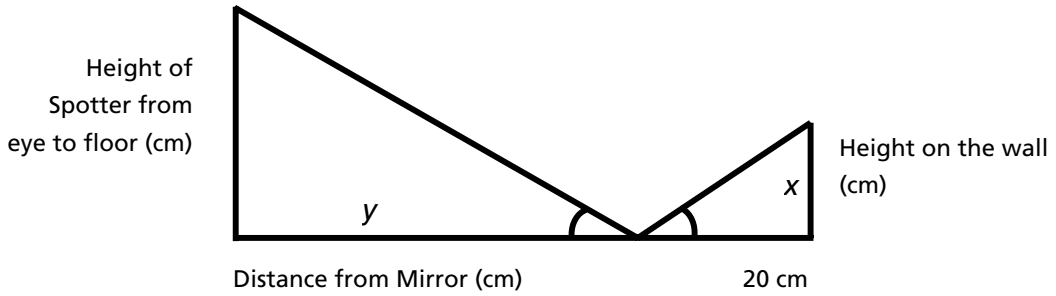


3. Press [TRACE] to see the plot. Press [▶] to view the data points.



Analyzing the data: Finding a function

The function that models this data is a rational function. Examine the information below to determine a rational model for the data.



Rational equation:

$$\frac{y}{\text{Height to Spotter (cm)}} = \frac{20\ (\text{cm})}{x}$$

or

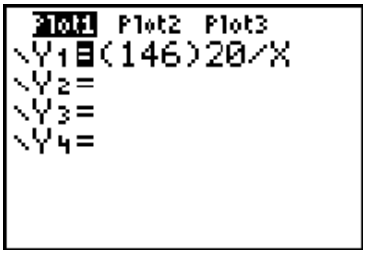
$$y = \frac{(\text{Height of Spotter}) \times (20)}{x}$$

Using the spotter's height, enter the rational model in *y*.

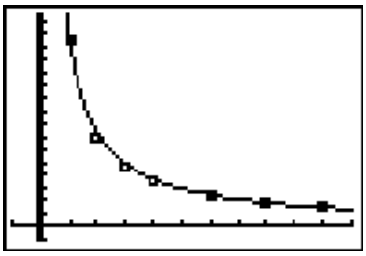
1. Press Y= (**1 4 6**) **2 0** ÷ *x*.

***Note**: In this example, the spotter's height was 146 cm. Replace this value with the actual height of your spotter.*

Record the equation on the **Data Collection and Analysis** page.



2. Press GRAPH to see the graph of the function.



Answer questions 1 through 6 on the **Data Collection and Analysis** page.

Data Collection and Analysis

Name_____

Date _____

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Collecting the data

Record your data in the table below.

Height (cm)	Distance from mirror (cm)
10	
20	
30	
40	
60	
80	
100	

Equation: _____

Analyzing the data

1. Use your equation to find the distance from the mirror if the height visible in the mirror is:
   - **a.** 45 cm _____
   - **b.** 110 cm _____
2. Use your equation to find the height on the wall if the spotter stands the following distances from the mirror:
   - **a.** 100 cm _____
   - **b.** 40 cm _____
   - **c.** 200 cm _____
3. What will happen to the graph of the data if the spotter is taller?

   _____

   _____

4. What will happen to the graph of the data if the spotter is shorter?

_____

_____

5. Determine the height of a classmate. Place a piece of masking tape on the wall to mark your classmate's height. Walk away from the mirror until you see the masking tape in the mirror. Use the equation to find your classmate's height.

_____

6. Find a classmate's height, in centimeters, using the meter stick. Determine where you would have to stand to see the top of the classmate's head.

_____

Teacher Notes

Activity 14

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Materials

- TI-73 graphing device
- Small mirror (one per group)
- Adding machine paper (at least 500 cm per group)
- Masking tape and markers
- Meter stick (one per group)

Preparation

- Use a marker for the numbering on the tape.
- Make sure students are not bending to see the numeral in the mirror.

Answers to Data Collection and Analysis questions

Collecting the data

Sample data:

Height (cm)	Distance from mirror (cm)
10	290
20	135
30	90
40	62
60	41
80	28
100	19

Find an equation for the data by using the formula.

For the sample data, $y = \frac{146(20)}{x}$.

Analyzing the data

1. Enter your equation in **Y1** in the TI-73. Use your equation to find the distance from the mirror if the height visible in the mirror is:

a. 45 cm. *Answers will vary. For the sample data, stand approximately 65 cm from the mirror.*

b. 110 cm. *Answers will vary. For the sample data, stand approximately 27 cm from the mirror.*

2. Use your equation to find the height on the wall if the spotter stands the following distances from the mirror:

a. 100 cm. *Answers will vary. For the sample data, the height on the wall is 29.2 cm.*

b. 40 cm. *Answers will vary. For the sample data, the height on the wall is 73 cm.*

c. 200 cm. *Answers will vary. For the sample data, the height on the wall is 14.6 cm.*

3. What will happen to the graph of the data if the spotter is taller?

The graph will appear to be shifted up if the spotter is taller.

4. What will happen to the graph of the data if the spotter is shorter?

The graph will appear to be shifted down if the spotter is shorter.

5. Determine the height of a classmate. Place a piece of masking tape on the wall to mark your classmate's height. Walk away from the mirror until you see the tape in the mirror. Use the equation to find your classmate's height.

Answers will vary.

6. Find a classmate's height, in centimeters, using the meter stick. Determine where you would have to stand to see the top of the classmate's head.

Answers will vary.