Rack 'Em Up — Teacher Notes

Topic Areas: Linear Inequalities, Linear Programming, Area

NCTM Standards:

- Identify functions as linear or nonlinear and contract their properties from tables, graphs, or equations;
- Use coordinate geometry to represent and examine the properties of geometric shapes;

Objective:

Given a photo file, students will be able to construct linear inequalities that create a polygon with specific dimensions and calculate the area of a polygon formed by linear programming.

Getting Started:

Prior to beginning the activity, determine the students' readiness to graph a system of linear inequalities design to form a particular shape.

Prior to using this activity:

- Students should be able to graph a linear function.
- Students should be able to graph a linear inequality.
- Students should understand the differences between greater than, less than, greater than or equal to, and less than or equal to.
- Students should be able to calculate the area of a triangle.

Ways students can provide evidence of learning:

- Given a linear inequality, students should be able to graph it by using pencil and paper, as well as with a graphing calculator.
- Given a triangle which is drawn on/off a coordinate plane, students should be able to calculate its area.

Common mistakes to be on the looking out for:

- Students may use the incorrect inequality symbol when graphing a linear inequality on the coordinate plane.
- Students may misidentify the slope and y-intercept of a linear inequality.
- Students may incorrectly calculate the area of a triangle.

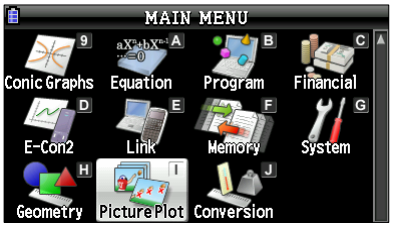
Definitions:

- Linear Inequalities
- Slope
- y-intercept
- Triangle

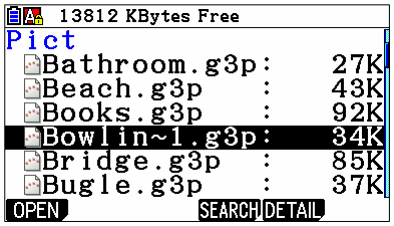
Rack ‘Em Up “How To”

The following will walk you through the keystrokes and menus required to successfully complete the Rack ‘Em Up activity.

To open a background image in Picture Plot:

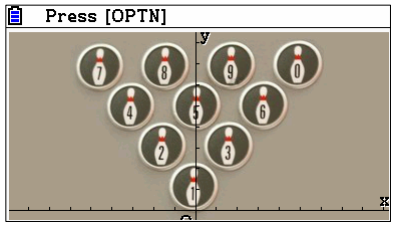


1. From the Main Menu, highlight the Picture Plot icon and press EXE or press (.

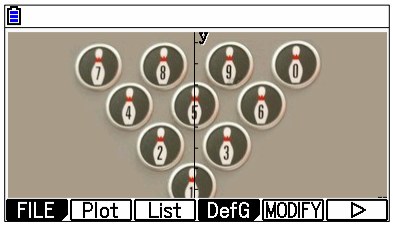


2. Press F1 (OPEN) to open the CASIO folder.

3. The g3p folder contains 47 background images. Press ▼ F1 (OPEN) to open the folder. Scroll down the list of images and highlight the desired image. You will be using the “Bowlin~1” image in this activity. Press F1 (OPEN).

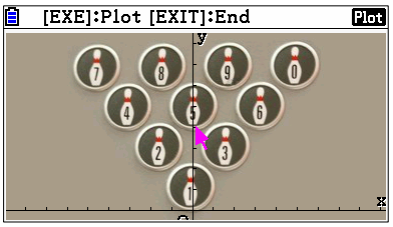


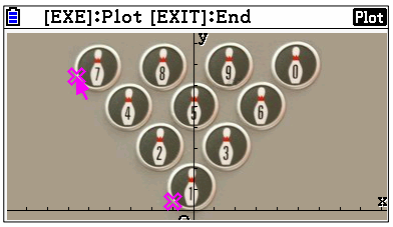
To plot points on the image and create a list of points:



1. The status bar at the top of the screen prompts what buttons you have to choose from. For this image, you will need to press OPTN .

2. To plot points on the image, press F2 (Plot).
A pink arrow will appear; use ◀ ▶ ▲ ▼ to move the arrow to where you would like for it to plot a point. (Any of the number keys can also be used to jump to different areas on the screen).
Press EXE to plot the point on the picture.

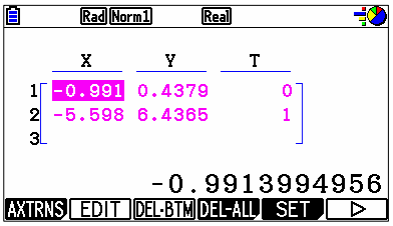




3. Continue moving the arrow and pressing EXE until you have all the points you want.
To stop plotting, press EXIT.

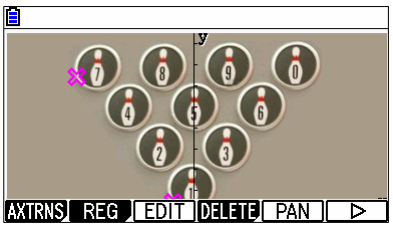
To view the list of data points:

1. Press F3 (LIST) to view the list of points plotted.
Press EXIT to go back to the image and points.

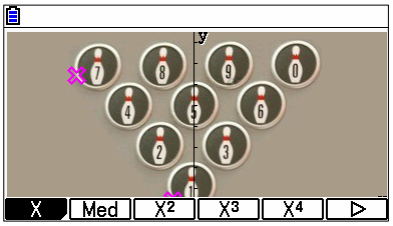


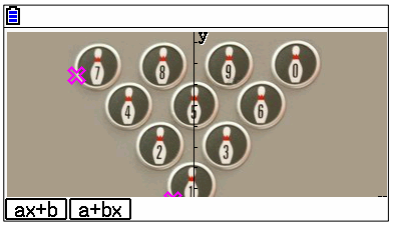
To create a best fit line or curve of best fit:

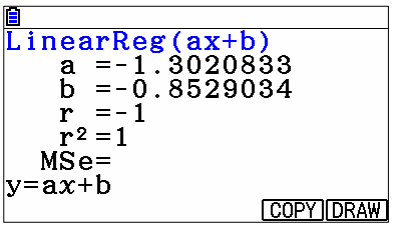
1. Press F6 (▷) and F2 (REG).



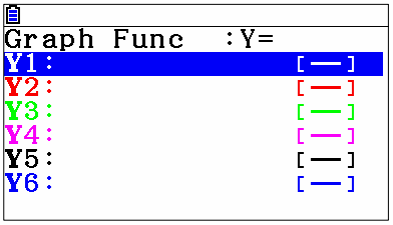
2. Choose the appropriate regression model.
In this case, it will be X, so press F1 and F1 (ax+b).



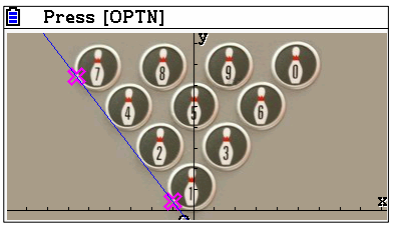




3. Press F5 (Copy) and EXE to copy the equation to the Graph menu.



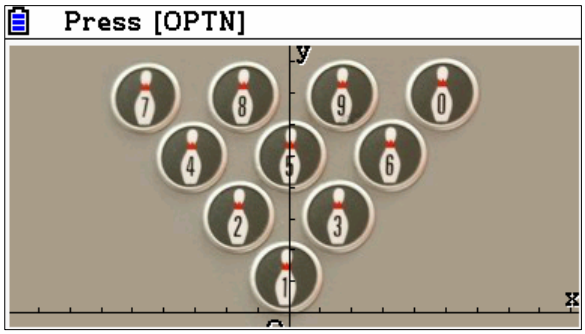
4. Press F6 (DRAW) to see the regression curve and the points.



Rack ‘Em Up Activity

Have you ever been bowling? If you have, you know the bowling pins are arranged at the end of the lane in the shape of a triangle. Each bowling pin is evenly spaced 12” apart from the center of one pin to the next. So, how much space is actually taken up by the bowling pins at the end of the lane? Perhaps knowing a little more about this will help you the next time you go bowling.

In this activity, you will determine the lines formed by the ten pins on a bowling lane. You will also determine how much space the bowling pins use and how to graphically represent that on your calculator. Finally, you will determine the amount of area the pins use at the end of a bowling lane.



Questions

1. Plot points for bowling pin #1 and bowling pin #7? What are the coordinates?

   _____

2. What is the equation of the line containing bowling pin #1 and bowling pin #7?

   _____

3. Plot points for bowling pin #1 and bowling pin #10. What are the coordinates?

   _____

4. What is the equation of the line containing bowling pin #1 and bowling pin #10?

   _____

5. Plot points for bowling pin #7 and bowling pin #10. What are the coordinates?

   _____

6. What is the equation of the line containing bowling pin #7 and bowling pin #10?

_____

7. Write each equation as a linear inequality, which will shade the area of the triangle formed by the bowling pins?

_____

_____

Extension

1. Is the line containing bowling pins #1, #2, #4 and #7 parallel with the line containing bowling pins #3, #5, and #8, as well as the line containing bowling pins #6 and #9? Explain your answer and prove your answer by accompanying screen shots.

_____

_____

_____

2. Is the line containing pins #1 and #7 perpendicular to the line containing pins #7 and #10? Explain your answer and prove your answer by accompanying screen shots.

_____

_____

_____

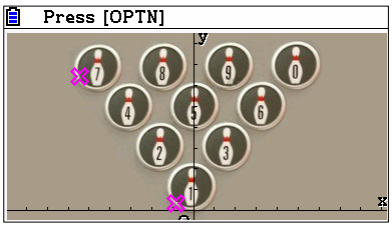
3. What is the area of the triangle formed when the bowling pin deck is shaded?

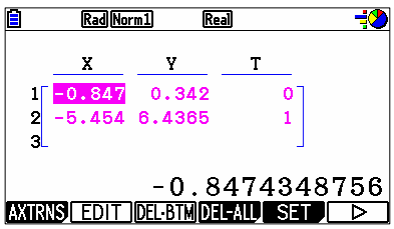
_____

Solutions

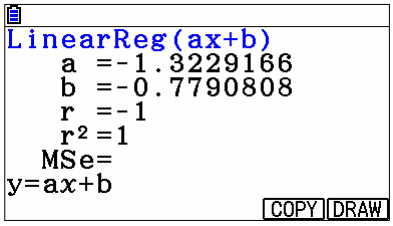
Answers will vary, depending on points plotted.

1. Bowling Pin #1: (–0.847, 0.342)
   Bowling Pin #7: (–5.454, 6.437)

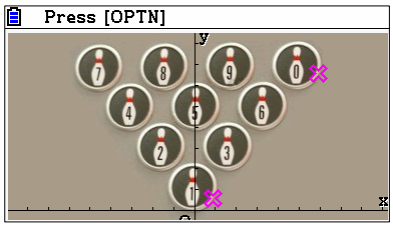


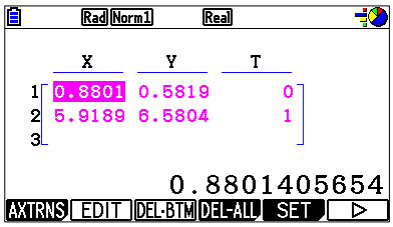


2. y = –1.323x – 0.779

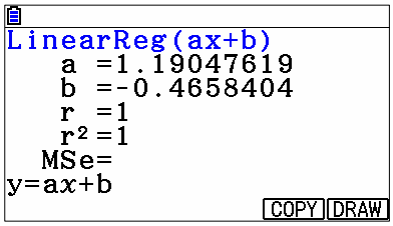


3. Bowling Pin #1: (0.880, 0.582)
Bowling Pin #10: (5.919, 6.580)

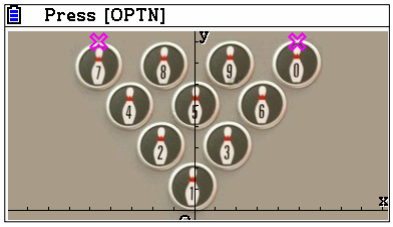


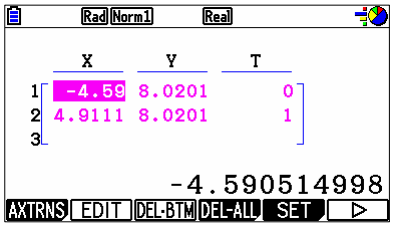


4. y = 1.190x – 0.466



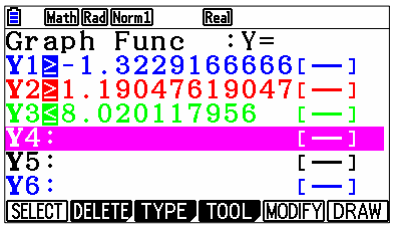
5. Bowling Pin #7: (–4.591, 8.020)
Bowling Pin #10: (4.911, 8.020)

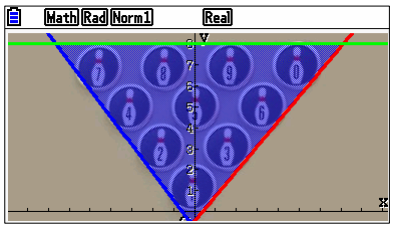




6. y = 8.020

7. $Y1 \geq -1.323x - 0.779$
$Y2 \geq 1.190x - 0.466$
$Y3 \leq 8.020$

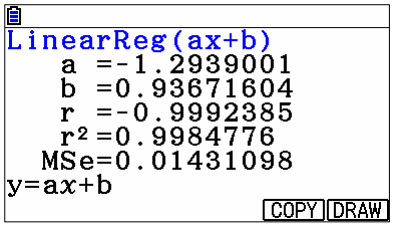


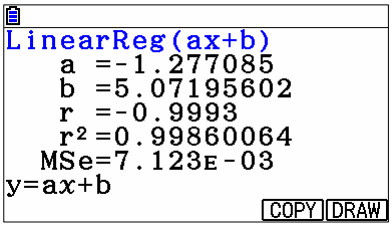


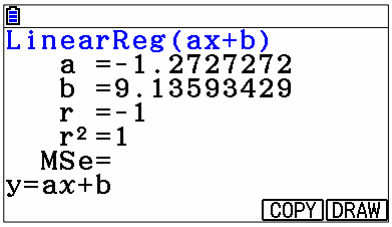
Extension Solutions:

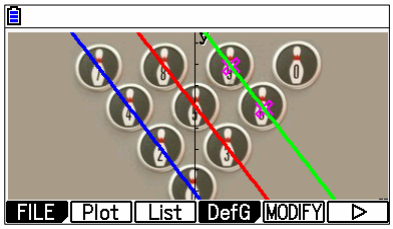
1. Yes, the three lines are parallel. After plotting points and performing linear regressions, we got the following equations:
Linear Equation for pins #1, 2, 4, 7: y = –1.294x + 0.937
Linear Equation for pins #3, 5, 8: y = –1.277x + 5.072
Linear Equation for pins #6, 9: y = –1.273x + 9.136

   In order for lines to be parallel, the slopes must be the same. Our three slopes are roughly the same. They may not be the exact same because of the points we plotted. We can not guarantee that we plotted each point in the middle of each pin, each time.





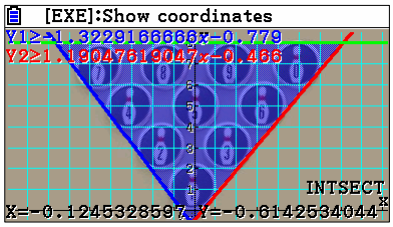


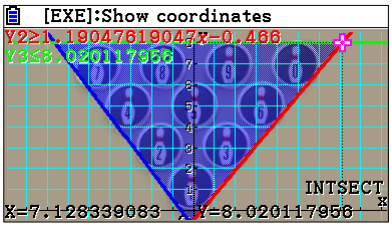


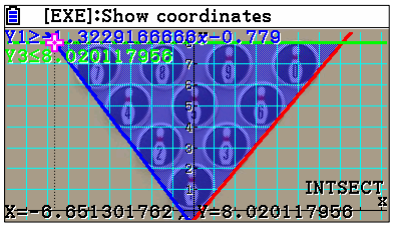
2. No, the two lines are not perpendicular. In order for two lines to be perpendicular, the slopes need to be the opposite reciprocals of each other. Essentially, if the slope of one line is $\frac{a}{b}$, then the slope of the line perpendicular to it needs to be $-\frac{b}{a}$. This is not the case with our two lines. The slope of the line containing pins #7 and #10 is 0. The equation of a line perpendicular to it would be x =.

3. To find the area of the triangle formed by the lines, we first need to find the points that represent each corner. To do so, while viewing the graph of the three inequalities, press F5 (G-Solv) F5 (INTSECT).

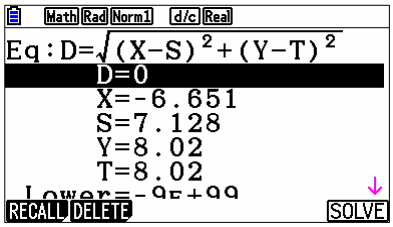
Point 1 (Intersection of **Y1** and **Y2**): (–0.125, –0.614)
Point 2 (Intersection of **Y2** and **Y3**): (7.128, 8.020)
Point 3 (Intersection of **Y1** and **Y3**): (–6.651, 8.020)

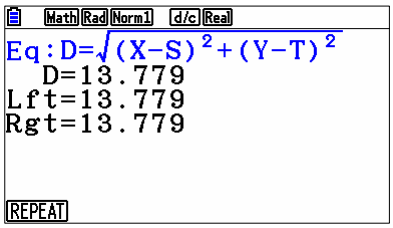




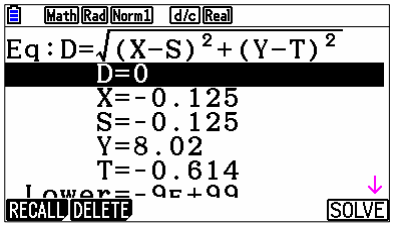


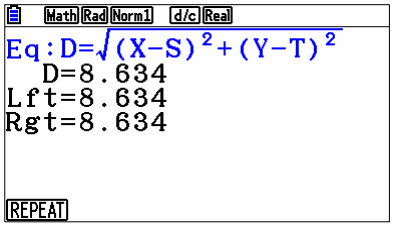
Now that we have the three corners, we can find the length of the base and the length of the height of the triangle. To find the length of the base, we need to find the distance from Point 2 to Point 3. (b = 13.779)





To find the height of the triangle, we will find the distance from Point 1 to point (-0.125, 8.020). We can't use Point 2 or Point 3, because the height has to be perpendicular to the base. (h = 8.634)





The area of a triangle is A = $\frac{1}{2}$bh. So, the area of our triangle, is

A = $\frac{1}{2}$(13.779)(8.634) = 59.484 units^2