

The Thirsty Crow

There is a very old fable about a crow and a partially filled pitcher of water. Here is a modern retelling of the story, taken from an ad for Birla Sun Life, an Indian investment company.

Today you get to play the part of the crow! Brainstorm a few ideas to get to the water - you are a thirsty crow! Think of this as an **Expo** project; use the ideas of Responsible Design and Natural Resources to make a plan.

Activity:

Gather your supplies: a cylindrical jar or glass filled about halfway, six stones, a ruler, and an iPad.

1. Measure the height of the jar to the nearest 0.1 cm. _____
2. Subtract 2 cm; that's the level at which the crow can reach the water. _____
3. Measure the starting height of the water in the jar and record it in the table, below 0 stones.
4. One by one add a stone to the water, recording the height of the water after each addition.

Stones Added	0	1	2	3	4	5	6
Water Height							

5. Plot your data on the grid below. Label your axes with the **independent variable** (rocks) and the **dependent variable** (water height). Mark the crow's goal with a horizontal line.

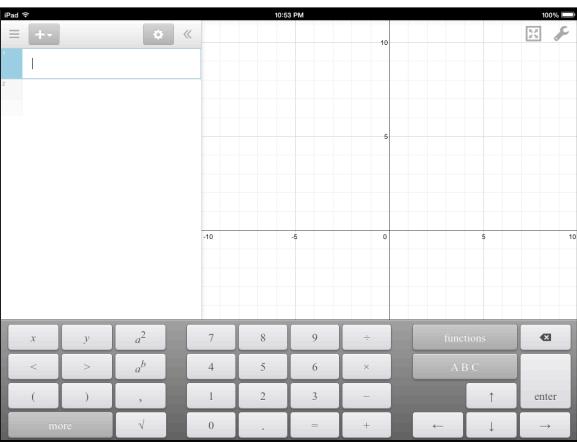


6. Stop and make a guess, without calculating. How many more stones does the crow need? _____

Analysis:

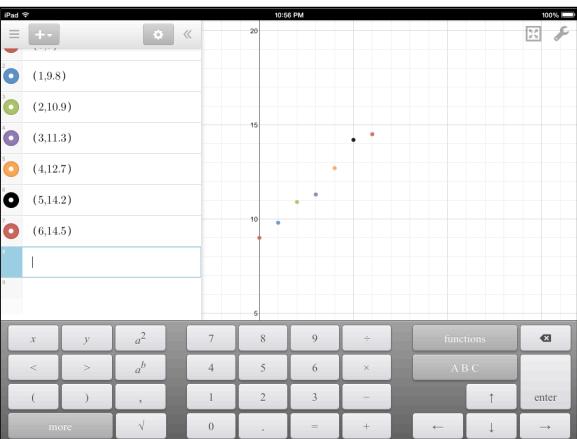
We will be using a free program called **Desmos** to graph and analyze our data.

Open the App on your iPad. You should see a screen like this.



The cursor is in the right place to enter an equation, a point, or a function.

We're going to start by plotting our data as ordered pairs (rocks, height).

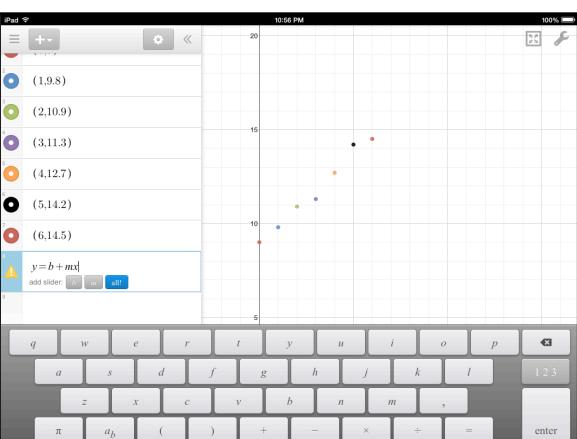


Tap the cursor. Tap the open parenthesis. Type your first data point, making sure to use a comma.

Take turns with your partner(s) adding the data.

Tap "enter" after each one.

When you are done it should look something like this. (Your data will be different than mine.)



We're going to fit a line through those points. The equation of that line will be a **mathematical model** of our data. (The graphs and tables are models, too!)

The equation will help us predict how many stones the crow needs to add.

In the next line, type $y = b + m \cdot x$

Desmos knows that y and x are variables. It wants to know if you want to be able to change the values of b and m , so it asks if you want sliders. Tap the blue button to create sliders for the **parameters**, b and m .

7. What does each of the letters in your equation represent?

y _____

x _____

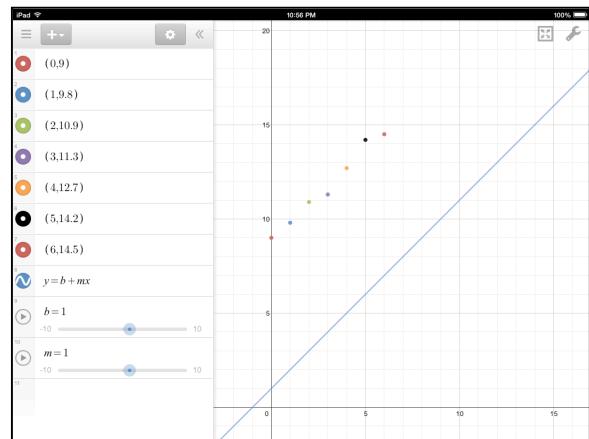
m _____

b _____

Move the sliders to fit the line to the points.

8. What does b change?

What does m change?

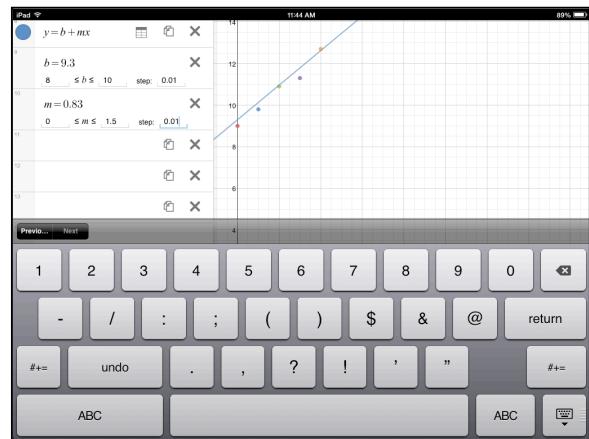


If you want finer control of the sliders, tap the gear to open the edit menu. Then you can change the lower and upper bounds for your sliders and the size of the steps.

When you get a good fit, record the values in your equation.

$$y = \underline{\hspace{2cm}} + \underline{\hspace{2cm}} x$$

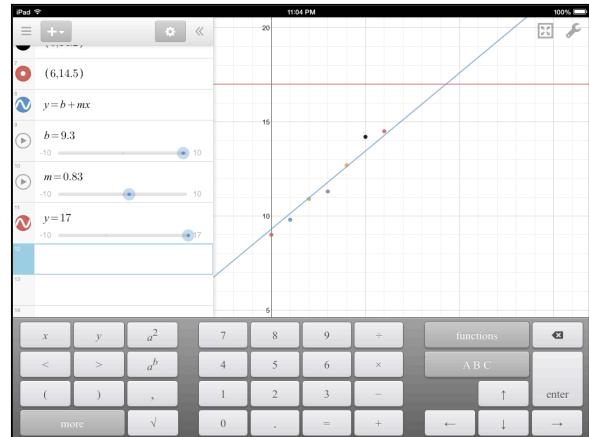
9. Does your b equal your initial water height? Why or why not?



Remember how we marked the crow's goal on our hand-made graph? Enter a new equation on the next line.

$$y = \text{your crow's goal}$$

Tap the point where the two lines meet and hold long enough for a point to appear and stay.



10. What is that point? What does it mean in the problem?

11. How many rocks (total) does the crow need to reach its goal? _____

Extensions:

12. Answer question [11] by writing and solving an equation.

13. Brainstorm all of the things that could change in the problem.

14. How would those changes effect the equation and graph?

15. Show what two of your changes would look like on the graph. Plot the horizontal goal line, the original line, a line where the slope is different, and a line where the y -intercept is different. Label axes.