Cell Phone Range

TEACHER NOTES

About the Lesson

In this activity, students will learn to identify the domain and range of various real-world step functions. They will graphically explore numerical data points and observe step functions. Extension questions are also provided to apply what is learned to determine the domain and range of other functions.
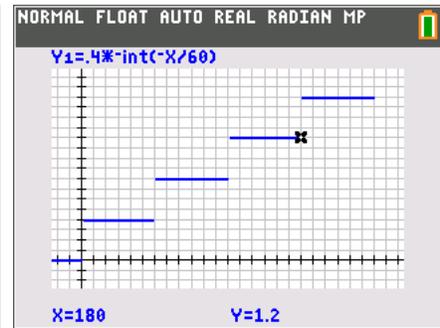
Vocabulary

- domain
- range

Teacher Preparation and Notes

- It would be beneficial for students to clear all lists and functions. Press 2nd [mem] and select **ClearAllLists**. Press y=, move to any equation that is defined and press clear on each equation.
- This activity can serve as a good introductory exploration to functions. It can be used in either an Algebra 1 or Algebra 2 class.

Activity Materials

- Compatible TI Technologies:

    TI-84 Plus*
    TI-84 Plus Silver Edition*
    🌐TI-84 Plus C Silver Edition
    🌐TI-84 Plus CE

* with the latest operating system (2.55MP) featuring MathPrint™ functionality.

NORMAL FLOAT AUTO REAL RADIAN MP

Y1=.4*-int(-X/60)

X=180   Y=1.2

Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- 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
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Lesson Files:

- CellPhoneRange_Student.pdf
- CellPhoneRange_Student.doc

Problem 1 – Cell Phone Situation

Explain the definition for domain and range. The cell phone situation is explained to be 40 cents per minute with a limitation of 4 minutes per call (240 seconds).

The fee for 0.5 seconds is 40 cents (written as $0.40). It is important for students to realize that $0.40 is not the same as 0.40 cents.
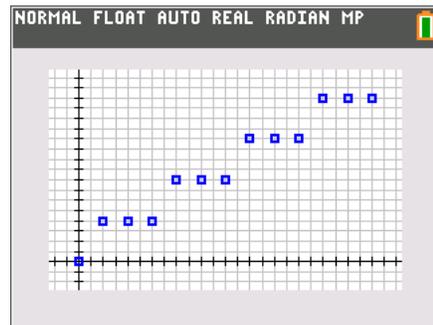

1. If he talks for 0.5 seconds, how much is the fee?

   Answer: The fee for 0.5 seconds is 40 cents (written as $0.40). It is important for students to realize that $0.40 is not the same as 0.40 cents.

2. If the cost is a function of time, what is the domain of the cost function?

   Answer: The domain is 0 < time ≤ 240 seconds

   The domain is 0 < time ≤ 240 seconds.

   Student can explore this situation using lists and graphs. The **int(** function is used to "round" the number to the next integer. This may take some explaining to students. Because the **int(** function is a floor function, taking the floor of the negative, and then changing it back to positive replicates the ceiling function.

3. Describe the graph.

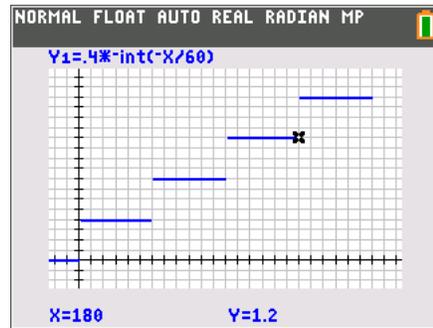   **Sample answer:** It looks like stairs.

4. What is the range of the cost function?

   Answer: The range is {$0.40, $0.80, $1.20, $1.60}

The range is {$0.40, $0.80, $1.20, $1.60}

Ensure students understand the relationship between the shown graph and the closed points (where the function is defined) and the open points (where the function in not defined).

5. Press [trace]. What is significant about the point just before and after the "step"? Enter some specific values to explore (60 and 61, 120 and 121, and so on).

   Sample Answer: The point just before the "step" is a full minute. The point just after the "step" is just over that minute.

6. Where does each step begin and end? How does this relate to the scatter plot and lists?

   Sample Answer: The point just before the "step" is a full minute. The point just after the "step" is just over that minute.

7. Which end points are included? Which are not? Draw the graph and indicate where the open circle ends should appear.

   Sample Answer: The end points on the left side of each step are not included. The end points on the right side of each step are included.
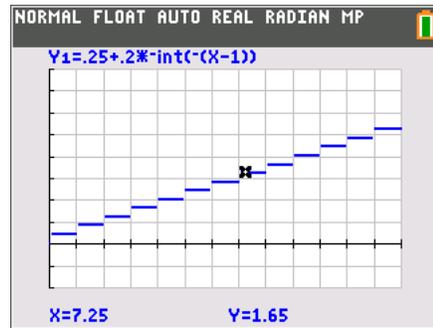
Problem 2 – Snail Mail "Pen Pal"

From April 3, 1988, to February 3, 1991, the U.S. postage rate for first class postage was $0.25 for the first ounce and $0.20 for each additional ounce. The letter must have weighed less than 13 ounces.

Students can use trace to find the cost for any weight between 0 and 13 oz. Discuss how this function is related to the function from Problem 1. Deciding on window settings is also worth discussing with students.

The domain is {*x*: 0 ≤ *x* < 13} You could lead the students in considering if the domain should be less than or equal to or only less than. The weight certainly cannot be negative. If zero ounces are mailed, then the cost is zero as shown in the graph.

8. The cost is a function of the weight. What is the domain of this function? Let *x* be the input and *y* be the output.

Answer: The domain is {*x*: 0 ≤ *x* < 13}
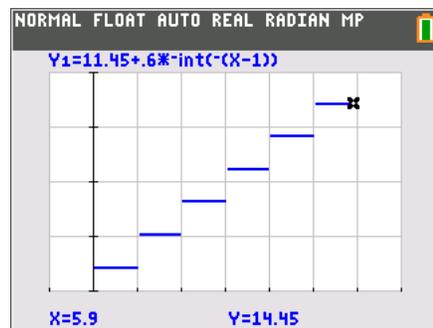
9. How much did it cost to mail a 7.25-ounce letter?

Answer: A 7.25-ounce letter cost $1.65.

10. This type of function is called a _____ function. What is the range?

Answer: This is a step function with a range of {*y*: *y* = 0.25, 0.45, 0.65, 0.85, 1.05, 1.25, 1.45, 1.65, 1.85, 2.05, 2.25, 2.45, 2.65}.

Extension/Homework 1 – Shipping

The students are given the situation where the shipping cost is $11.45 for the first pound and $0.60 more for each additional pound. You decide you can only spend $15 for shipping.

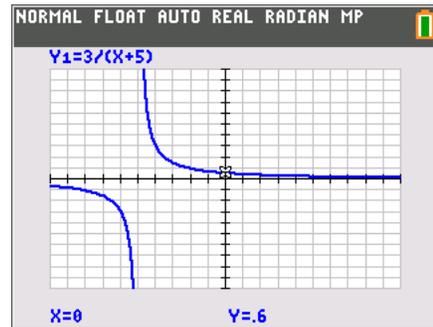**11.** What is the domain of the cost function for shipping a package?

Answer: The domain is {x: $0 < x < 6$}.

12. What is the range for this cost of shipping function? Make a sketch of what the graph would look like.

Answer: The range for this function that again looks like a step function is {y: y = 11.45, 12.05, 12.65, 13.25, 13.85, 14.45}

Extension/Homework 2 – Functions

Various functions are considered. The domain is restricted by the allowable inputs. Dividing by zero and taking the square root of negative numbers are not allowed. A graph of these functions can be helpful by allowing students to see that the domain can be limited. Similarly, have students graph the function and ask what output values occur for functions like $y = x^2$.

13. $y = x^2$

Answer: $y = x^2$, **domain**: {x: $x \in \Box$ }, **range**: {y: $y \geq 0$}

14. $y = \dfrac{3}{x+5}$

Answer: $y = \sqrt{x}$, **domain**: {x: $x \geq 0$}, **range**: {y: $y \geq 0$}

15. $y = \sqrt{x}$

Answer: $y = \dfrac{5}{x}$, **domain**: {x: $x \neq 0$}, **range**: {y: $y \neq 0$}

16. $y = \sqrt{2x-6}$

Answer: $y = \dfrac{3}{x+5}$, **domain**: {x: $x \neq -5$}, **range**: {y: $y \neq 0$}

17. $y = \dfrac{5}{x}$

Answer: $y = \sqrt{2x-6}$, **domain**: {x: $x \geq 3$}, **range**: {y: $y \geq 0$}