LESSON 1

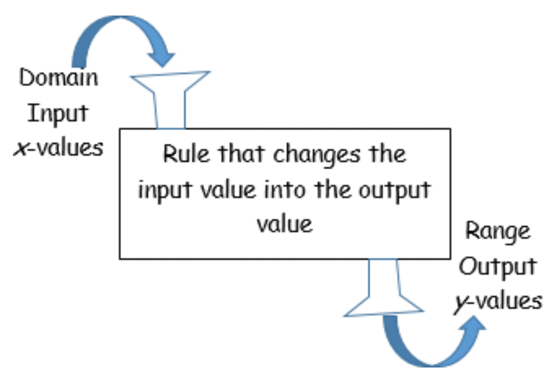
What's My Rule?

LEARNING OBJECTIVES

- Today I am: playing the *What's My Rule* game with my partner.
- So that I can: see how function notation can help me organize my game results.
- I'll know I have it when I can: find $f(2)$ using an equation or a graph.

Exploratory Activity

In Module 2, we looked at an "Algebra" machine, as shown on the right. There is a rule that is used to determine the output value given any input value. Today, you and your partner will take turns being the Algebra Machine. You will try to determine the rule after getting several output values for specific input values.



domain
input → x-value (independent)

output → y-value (dependent)
range

$y = x - 2$

↑ output ↑ input

You will need: *What's My Rule?* game cards

1. Play the *What's My Rule?* game.

Directions:

- Player 1 randomly selects a card from the Rule card pile.
- Player 2 tells Player 1 a number. This is the input value.
- Player 1 uses the input value (x-value) in the rule selected and tells Player 2 what the output value (y-value) is.
- Player 2 can get another input value or try to guess the rule.
- Player 2 has at most three guesses but may give up to five different input values.
- Players switch roles after the rule is either successfully discovered or the player has run out of guesses.

You may use the space below to record your input and output values.

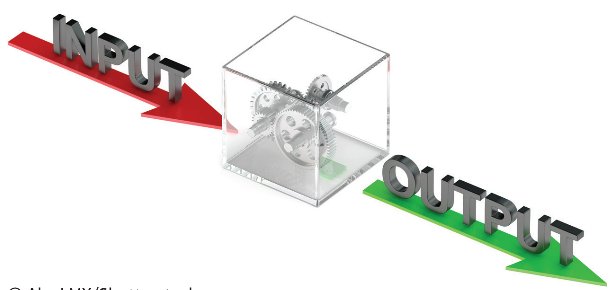
Discussion

2. A. Which rules were the most difficult to guess? Why?

   B. Which input values gave you the best chance of guessing the rule? Why?

   C. Were there any input values that didn't seem to help at all? Explain.

   D. How did you organize your data in the game? How did that help or hinder you in finding the rule?



You may have found it difficult to keep track of all the input and output values during the game of *What's My Rule*. One way we could better organize the data is with a table of values. Another way is to use a new notation for these rules. In *function notation*, we can specify which input value was used to arrive at each output value.

(x, f(x))

3. In function notation, the rule $y = 2x + 1$ would be written $f(x) = 2x + 1$. What does $f(x)$ represent?

f(*x*) is said, "*f* of *x*" or "*f* at *x*" or "the value of the function at *x*".

$x = 1$
$f(1) = 2(1) + 1$ (1, 3)
$f(1) = 3$ At x=1, y is 3.

4. For an input value of 0, we would write $f(0) = 2 \cdot 0 + 1$ or $f(0) = 1$. What are the (x, y) values of this example?

f of zero.
At x=0, y is 1 → (0, 1)

5. Given $f(x) = 3x - 2$, find

A. $f(0)$

$f(0) = 3(0) - 2$
$f(0) = -2$

B. $f(2)$

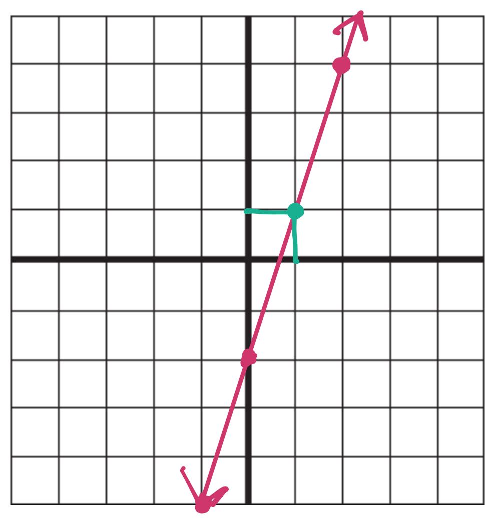
$f(2) = 3(2) - 2$
$f(2) = 4$

C. $f(-1)$

$f(-1) = 3(-1) - 2$
$f(-1) = -5$

6. Write each input and output value from Exercise 5 in the form (x, y). Then plot the points on the grid at the right. Connect the points to form a line.

(0, −2) (−1, −5)
(2, 4) (x, f(x))



7. A. Use the graph to find the value of $f(1)$. Mark this point on your graph.

B. Find $f(1)$ using the equation $f(x) = 3x - 2$. Is your answer the same as in Part A?

f(1) = ?
When x is 1
what is y? y = 1

$f(1) = 3(1) - 2$
$= 1$

Practice with Function Notation

8. Given: $f(x) = -3x + 5$. Find:

A. $f(2)$

$f(2) = -3(2)+5$

$f(2) = -1$

B. $f(-3)$

$f(-3) = -3(-3)+5$

$f(-3) = 14$

C. $f(2) + f(-3)$

$-1 + 14 = 13$

9. Given: $f(x) = \frac{1}{2}x + 2$. Find:

A. $f(2)$

$f(2) = \frac{1}{2}(2)+2$

$f(2) = 3$

B. $f(-4)$

$f(-4) = \frac{1}{2}(-4)+2$

$f(-4) = -2+2$

$f(-4) = 0$

C. $f(2) - f(-4)$

$3 - 0 = 3$

10. Use the graph to find the values below.

A. $f(2)$ (2, -1)

$x = 2$

$y = -1$

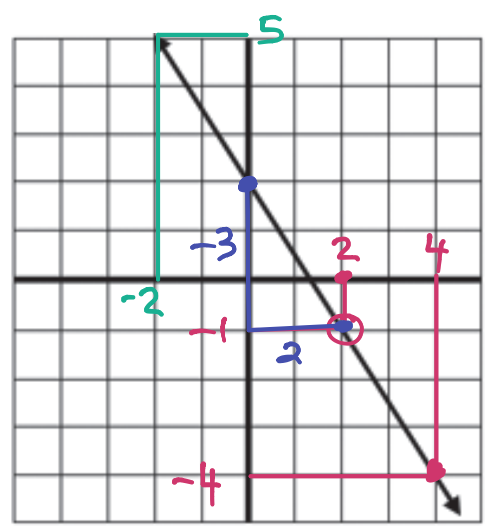
B. $f(-2)$ (-2, 5)

when $x = -2$

$f(-2) = 5$

C. $f(0)$ $= 2$ (0, 2)

when $x = 0$, $y = 2$



11. Find x when $f(x) = -4$.

$x = 4$

12. A. Determine the equation of the line at the right in slope-intercept form.

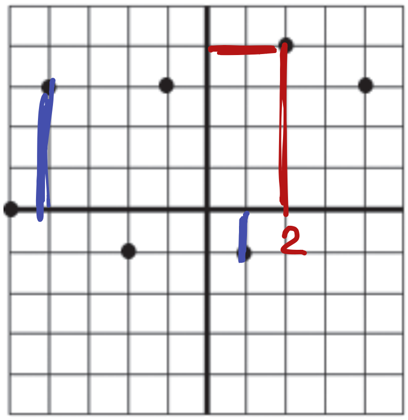
$y = mx + b$

$y = \frac{-3}{2}x + 2$

B. Which value in Exercise 10 can be seen easily in the equation from Part A? What is important about this point?

Function notation is not limited to lines. Let's explore this idea for each non-linear function below.

13. Discrete Data Points

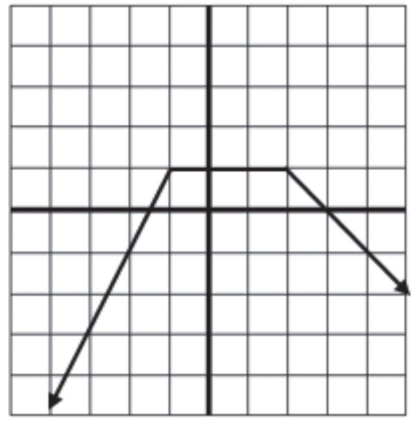


A. $f(-4) =$ 3

B. $f(1) =$ −1

C. when $f(x) = 4$, $x =$ 2

14. Piecewise Functions

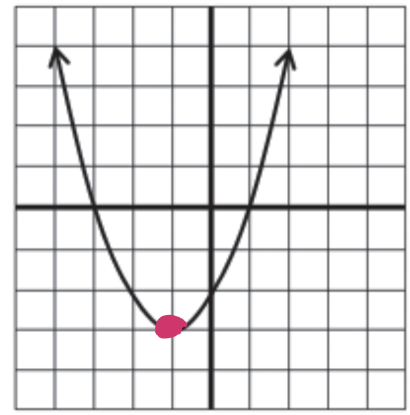


A. $f(-3) =$ −3

B. $f(2) =$ 1

C. when $f(x) = -1$, $x =$ −2 or 4

15. Curved Functions



A. $f(-1) =$ −3

B. $f(1) =$ 0

C. when $f(x) = 4$, $x =$ 2 or −4

16. Curved Functions

$f(x) = 2x^2 - 3x + 4$

A. $f(-1) =$ ______

B. $f(1) =$ ______

17. Discrete Data Points

(2, −4); (−3, 5); (0, −4); (1, 1); (−4, 2)

A. $f(-4) =$ 2

B. $f(1) =$ 1

C. when $f(x) = 5$, $x =$ −3

18. Piecewise Functions

$f(x) = \begin{cases} 2x + 1, & x \geq 2 \\ -x - 1, & x < 2 \end{cases}$

A. $f(-3) = -(-3) - 1 = 3 - 1 = 2$

B. $f(2) = 2(2) + 1 = 5$

C. when $f(x) = 5$, $x =$ 2 or −6

$f(-1) = 2(-1)^2 - 3(-1) + 4$

$= 2(1) + 3 + 4$

$= 2 + 3 + 4$

$f(-1) = 9 \rightarrow (-1, 9)$

$f(1) = 2(1)^2 - 3(1) + 4$

$= 2(1) - 3 + 4$

$= 3$

$2x + 1 = 5$

$2x = 4$

$x = 2$

$-x - 1 = 5$

$-x = 6$

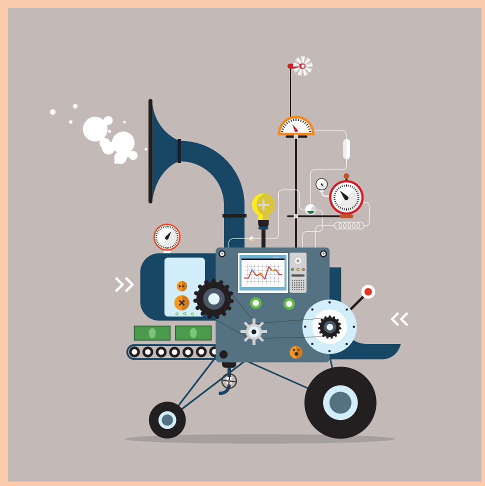
$x = -6$

Lesson Summary

Function notation allows us to keep track of each ordered pair that is a solution of the function. In the example below, two linear functions are evaluated when $x = 2$.

$y = 5x - 3$	$f(x) = 5x - 3$
Find y when $x = 2$.	Find $f(2)$.
$y = 5 \cdot 2 - 3$	$f(2) = 5 \cdot 2 - 3$
$y = 10 - 3$	$f(2) = 10 - 3$
$y = 7$	$f(2) = 7$
Solution: $(x, y) = (2, 7)$	Solution: $(x, f(x)) = (2, 7)$

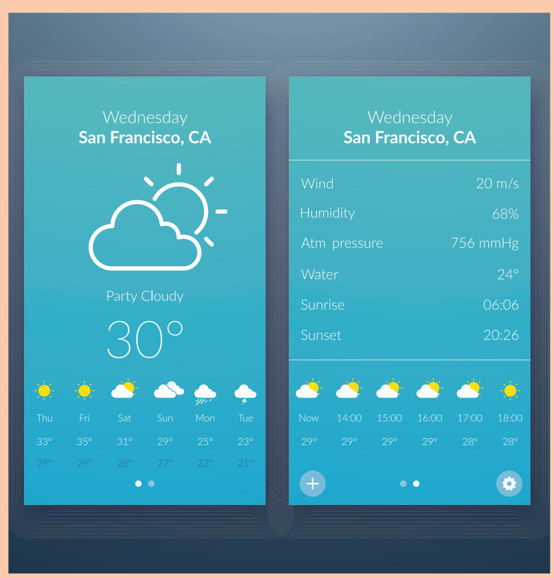
Functions are mathematical building blocks for designing machines, predicting natural disasters, curing diseases, understanding world economies and for keeping airplanes in the air. Functions can take input from many variables, but always give the same output, unique to that function.



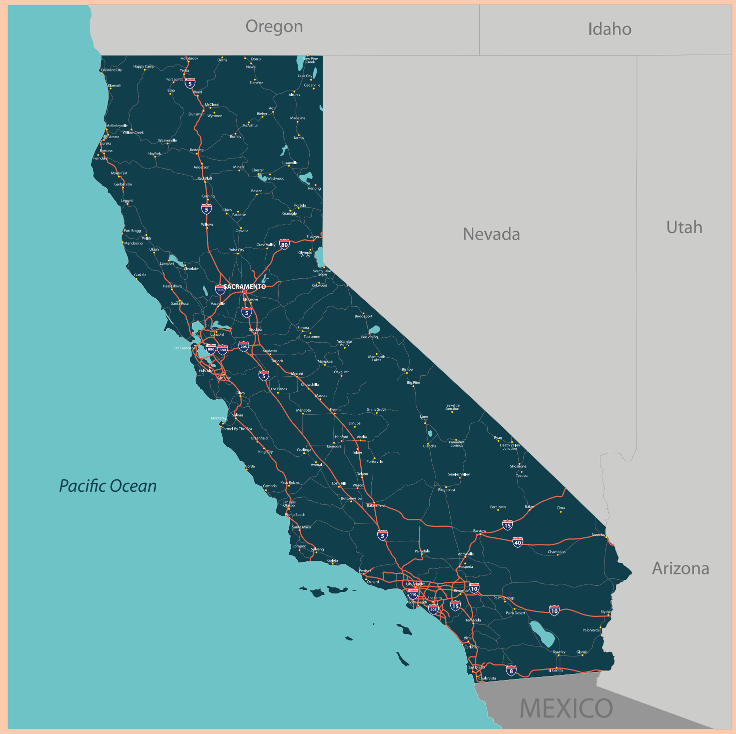
Functions also allow us to visualize relationships in terms of graphs, which are much easier to read and interpret than lists of numbers.

Some examples of functions include:

- Temperature is a very complicated function because it has so many inputs, including: the time of day, the season, the amount of clouds in the sky, the strength of the wind, where you are and many more. But the important thing is that there is only one temperature output when you measure it in a specific place.



- Location as a function of time. You can never be in two places at the same time. If you were to plot the graphs of where two people are as a function of time, the place where the lines cross means that the two people meet each other at that time. This idea is used in logistics, an area of mathematics that tries to plan where people and items are for businesses.



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Function notation is a very useful way to express a function.

Another way of writing $y = 2x + 1$ is $f(x) = 2x + 1$. We say "f of x is equal to $2x + 1$".

Any letter can be used, for example, $g(x)$, $h(x)$, $p(x)$, etc.

Example 1: Determine the output value:

"Find the value of the function for $x = -3$" can be written as: "find $f(-3)$".

Replace x with -3:

$$f(-3) = 2(-3) + 1 = -5$$

This means that when $x = -3$, the value of the function is -5.

Example 2: Determine the input value:

"Find the value of x that will give a y-value of 27" can be written as: "find x if $f(x) = 27$".

We write the following equation and solve for x:

$$2x + 1 = 27$$

$$2x = 26$$

This means that when $x = 13$ the value of the function is 27.

NAME: ______________________ PERIOD: __________ DATE: __________

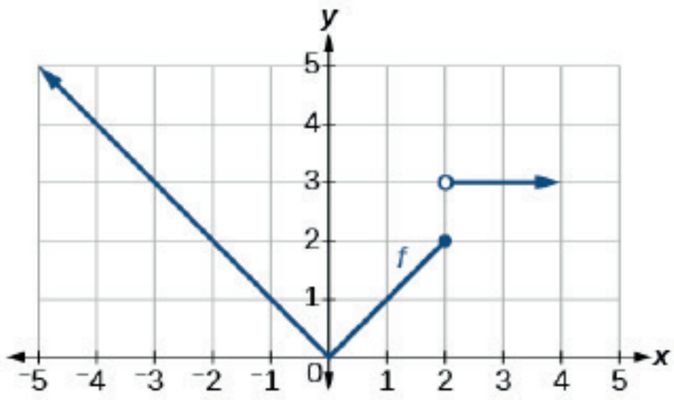
Homework Problem Set

1. Use the graph of $f(x)$ at the right to answer the following:

   A. Find $f(-2)$

   B. Find $f(2)$

   C. Find $f(11)$



   D. For what value of x is $f(x) = 4$?

   E. For what value of x is $f(x) = 3$?

2. In the *What's My Rule?* game, Tyr had the following input and output values. What is the rule for Tyr's values?

Input (x-value)	-2	-1	0	1
Output (y-value)	0	1	2	3

3. In the *What's My Rule?* game, Lily had the following input and output values. What is the rule for Lily's values?

Input (x-value)	-2	-1	0	1
Output (y-value)	4	2	0	-2

4. **Challenge** In the *What's My Rule?* game, Davis had the following input and output values. What is the rule for Davis' values?

Input (x-value)	-2	-1	0	1
Output (y-value)	3	1	-1	-3

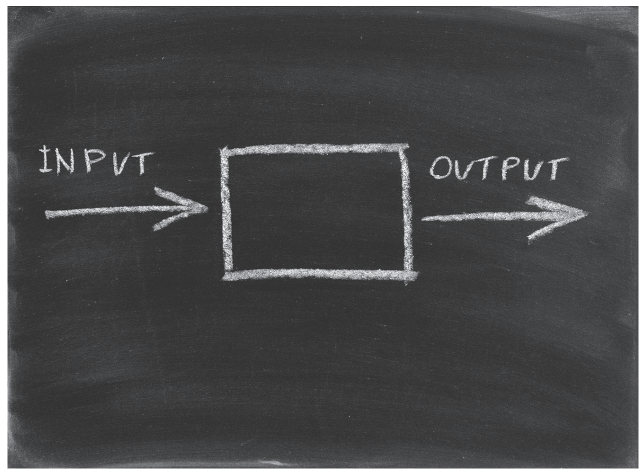
5. **Open Ended** Find at least three different rules that could have an input value of 2 and an output value of -3.

Rule 1: ______________________________

Rule 2: ______________________________

Rule 3: ______________________________

6. What input value is needed for an output value of 5 with the function $f(x) = -x + 4$? How do you know you are correct?



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7. What input value is needed for an output value of -2 using the function $f(x) = 2x + 4$? How do you know you are correct?

8. Complete the table and then write the linear function's rule.

x	$f(x)$
12	6
10	4
8	2
6	
0	
	-10

Find each of the following.

9. If $f(x) = 2x - 1$, then $f(-2) =$ ________.	10. If $g(x) = \sqrt{x+5}$, then $g(11) =$ ________.	11. If $h(x) = x^2 - 3x + 5$, then $h(-3) =$ ________.
12. If $g(x) = \sqrt{x+5}$, then $g(-4) =$ ________.	13. If $h(x) = x^2 - 3x + 5$, then $h(0) =$ ________.	14. If $f(x) = 2x - 1$, then $f(1) =$ ________.
15. If $k(x) = 2$, then $k(0) =$ ________.	16. If $k(x) = 2$, then $k(-2) =$ ________.	17. If $k(x) = 2$, then $k(3) =$ ________.

Spiral REVIEW—Solving Equations

18. $6x - 3 = 9$	19. $\frac{x}{2} + 5 = 7$
20. $\frac{x}{3} - 4 = 2$	21. $2x + 1 = 5x + 10$