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LESSON 17 Understanding Functions CCLS: 8.F.1

1 Introduction

A **function** is a rule that relates an input value to an output value. Each input gives exactly one output. For example, $y = 3x + 4$ is a function. Each value of x yields exactly one value of y . The rule that relates the values is that each value of y is 4 more than 3 times the value of x .

The set of input values, or x -values, of a function is the **domain**. The set of output values, or y -values, of a function is the **range**. The rule explains how the range is related to the domain. One way to identify a function is from a set of ordered pairs.

Which of the following sets represents a function?

Set 1: $\{(2, 3), (2, 4), (2, 5), (2, 6)\}$
 Set 2: $\{(2, 4), (3, 4), (5, 7), (1, 1)\}$

In set 1, the input value 2 is associated with 3, 4, 5, and 6. Because the same input value is associated with more than one output value, the relationship is not a function.

In set 2, each input value is associated with exactly one output. So, set 2 represents a function.

Another way to identify a function is from a graph.

Does this graph represent a function?

Each point on the graph is an ordered pair that relates an x -value to a y -value. You can see that each x -value is associated with only one y -value, so the graph represents a function.

In a function, no two inputs, or x -values, are the same.

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Objective

To identify functions and the domain and range in a function

1 Introduction

Discuss with students the definition of a function: in a function, each input has exactly one output. Look at the sample problem and identify the function. Then identify the domain, or input, values and the range, or output, values of the function. Next, discuss the vertical-line test and show students how to decide if a graph shows a function.

Think About It

Students should recognize what a function is and be able to name a real-life situation that is a functional relationship. An example is the relationship between the number of letters mailed and the number of stamps needed.

Common Core Learning Standard

8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

Vocabulary

domain: the set of input values in a function
function: a relationship between two sets of variables, called the input and the output. In a function, there is one unique output (y -value) for each input (x -value).
range: the set of output values in a function
vertical-line test: a way of deciding if a graph is a function by drawing a vertical line any place on the graph and observing if the line passes through more than one point on the graph

To check if a graph represents a function, you can use the **vertical-line test**. If a vertical line drawn anywhere on the graph passes through at most one point, the graph represents a function. If a vertical line passes through two or more points, the graph does not represent a function.

Think About It

What is an example of a functional relationship that you may encounter in real life?

2 Focused Instruction

Some functions follow a specific rule to show how the input changes to the output. Find the rule by looking at the values in the function.

► The table shows the cost for a given number of granola bars in a snack machine.

Number of Granola Bars	1	2	3
Amount (\$)	0.75	1.50	2.25

What is the input? the number of granola bars
 List the given input values. 1, 2, 3
 What is the output? the amount of money
 List the given output values. \$0.75, \$1.50, \$2.25
 What output value(s) is related to the input value of 1? \$0.75
 What output value(s) is related to the input value of 2? \$1.50
 What output value(s) is related to the input value of 3? \$2.25
 Are any input values related to more than one output value? no
 Is the relationship for the snack machine a function? yes
 Look at how the input value changes to get the output value. Is the output greater than or less than the input? less than

The output depends on the input.

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2 Focused Instruction

First, students will use a table to write an equation that describes the given function. Students must recognize the input and output values from the table and understand their relationship. Then students will analyze two tables to decide which, if either, show a function. Students should be able to translate the values in the table to ordered pairs and decide if the relationships are functions.

Conclude the Focused Instruction section by having students decide if three relationships are or are not functions.

2 Focused Instruction Lesson 17

By how much does the output change when the input changes by 1?
0.75

Write an equation to show the rule that tells how the input is related to the output. $y = 0.75x$

Use the tables to compare two relationships.

► The tables show the x - and y -values for two different relationships. Which one, if either, represents a function?

RELATIONSHIP A	
x	y
5	15
10	30
20	60

RELATIONSHIP B	
x	y
2	-3
4	1
4	5

Look at the input and output values for relationship A.
 Write a set of ordered pairs based on the values in the table.
 $(5, 15), (10, 30), (20, 60)$

Are any values of x associated with more than one value of y ? Explain.
No, each value of x results in one value of y .

Does relationship A represent a function? yes

Look at the input and output values for relationship B.
 Write a set of ordered pairs based on the values in the table.
 $(2, -3), (4, 1), (4, 5)$

Are any values of x associated with more than one value of y ? Explain.
Yes, the input value 4 is associated with an output of 1 and 5.

Does relationship B represent a function? no

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2 Focused Instruction Lesson 17

Use what you know about functions to decide whether or not each of the following sets of points shows a function. Write yes or no.

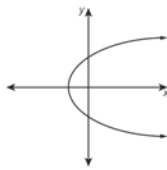
1 $\{(1, -3), (4, 4), (5, 8), (6, 4)\}$ yes

2

x	0	2	4	6	8
y	1	1	1	1	1

yes

3



no

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Connections to Standards for Mathematical Practice

- Make sense of problems and persevere in solving them.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and make use of structure.

3 Guided Practice Lesson 17

Solve the following problems.

1 The Miller family owns a bakery. They made a graph of their profits over 10 weeks. Does the graph represent a function? Explain your response.



The weeks are the input values. Count the number of points shown for each week.

Yes, each day is associated with one profit value.

2 Write a function rule to describe the data in this function table.

x	-20	-10	0	10
y	-6	4	14	24

How does the value of x change to get the value of y?

Answer *y = x + 14*

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3 Guided Practice

Students should complete the Guided Practice section on their own. Offer assistance as needed, pointing out the reminder and hint boxes along the right side of the page.

4 Independent Practice Lesson 17

Solve the following problems.

1 Which of the following sets are functions? Select **all** that apply.

- A $\{(0, 1), (0, 2), (0, 3), (0, 4)\}$
- B** $\{(0, -1), (-1, 0), (-2, 5), (-3, -2)\}$
- C $\{(1, 1), (3, 2), (3, 3), (5, 4)\}$
- D $\{(2, 3), (3, 1), (1, 2), (2, 1)\}$
- E** $\{(3, 3), (2, 2), (1, 1), (0, 0)\}$
- F** $\{(3, -1), (4, -1), (5, -1), (6, -1)\}$

2 Which table does not represent a function?

A

x	y
1	4
2	4
3	4

B

x	y
2	3
2	4
2	5

C

x	y
1	1
3	3
5	5

D

x	y
2	6
4	4
6	2

DOK 1 8.F.1

DOK 2 8.F.1

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4 Independent Practice Answer Rationales

1 A function is a relationship where each input value is associated with one, and only one, output value. In choice A, the input value 0 is associated with four different output values. In choice C, the input value 3 is associated with two different output values. In choice D, the input value 2 is associated with two different output values. These choices are incorrect. In choices B, E, and F, each input value is associated with only one output value. These relationships are functions.

2 Choice A is incorrect. Even though the output values are the same, each input value appears only once, so it is a function. Choice C is incorrect. Even though each output value is the same as the related input value, each input value appears only once, so it is a function. Choice D is also a function. Each input value appears only once. In choice B, all the x-values, or input values, are 2, so the input value of 2 is associated with output values of 3, 4, and 5. This is not a function. Choice B is correct.

3 In a function, each input value has one and only one output value. In order for this table to not represent a function, one of the input values must be related to more than one output value. That means that the value of h can equal any of the three given input values: 2, 5, and 7. The output value does not affect whether or not a relationship is a function. Output values can repeat or can be different. The value of k can be any number.

4 An easy way to test if a graph represents a function is to use the vertical-line test. If a vertical line can be drawn through any part of the graph and only intersect one point, the graph is a function. Since this graph passes the vertical-line test, it is a function.

5 PART A The input of the function is the domain, or the independent variable. The x -value in each ordered pair is the input. The output is the range, or the dependent variable. The y -value in each ordered pair is the output.

PART B Match the inputs with the outputs as outlined in the problem. Each input will associate with exactly two outputs. The points $(1, 1)$ and $(1, 5)$ both have an input of 1, but the outputs are different. So 1 in the domain is connected to 1 and 5 in the range. The points $(5, 8)$ and $(5, 3)$ both have 5 as an input. So 5 in the domain is connected to 3 and 8 in the range. The points $(10, 20)$ and $(10, 6)$ both have 10 in the domain; 10 is connected to 20 and 6 in the range.

PART C In a function, each input will have exactly one output. In this situation, each input has exactly two outputs, so this is not a function.

4 Independent Practice Lesson 17

3 The ordered pairs (x, y) in this table of values do not form a function. **DOK 3 8.F.1**

IN	OUT
2	1
5	k
7	6
h	9

What could be possible values of h and k ? Explain how you know.
The value of h is 2, 5, or 7. When h is 2, 5, or 7, it is not a function because one of the x -values repeats. The value of k can be any number, it does not affect whether or not the table shows a function.

4 Does the graph represent a function? Explain how you know. **DOK 1 8.F.1**

Yes, each value of x is associated with only one value of y .

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4 Independent Practice Lesson 17

Look at the set of points below.
 $\{(1, 1) (5, 8) (1, 5) (10, 20) (10, 6) (5, 3)\}$

Part A What is the input?
Answer 1, 5, 1, 10, 10, 5

What is the output?
Answer 1, 8, 5, 20, 6, 3

Part B Use arrows to connect the elements of the domain to the range.

Part C Is this relationship a function? Explain how you know.
This relationship is not a function because each element of the domain is associated with two elements of the range.

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4 Independent Practice

Lesson 17

6 Jasper wrote this function table.

x	y
-4	-7
-3	-6
-2	-5
-1	-4

DOK 2
8.F.1

Part A Write a function rule that models this relationship.

Answer $y = x - 3$

Part B What is the value of x when $y = -9$? Explain how you know.

-6; Use the inverse of the rule. Since $y = x - 3$, $x = y + 3$, so when $y = -9$, $x = -9 + 3 = -6$.

7 Reilly is buying DVDs that cost \$10.00 each. There is a shipping charge of \$3.95. The function that represents the total cost of x DVDs is represented by $y = 10x + 3.95$. Complete the table to represent this function.

DOK 2
8.F.1

x	1	3	5	7	10
y	13.95	33.95	53.95	73.95	103.95

6 PART A To determine the function rule, figure out how the x - and y -values are changing in relationship to each other. In this table, 3 is subtracted from each x -value to get the corresponding y -value, so the equation that represents this relationship is $y = x - 3$.

PART B The relationship in the table is given in the equation $y = x - 3$. Substitute $y = -9$ into the equation and solve for x : $-9 = x - 3$; $-9 + 3 = x$; $x = -6$. Students may also recognize that the inverse of the rule is $x = y + 3$ and use this equation to find the value of x .

7 Using the given equation, substitute the values for x from the table to get the y -values:
 $y = 10(1) + 3.95 = 13.95$; $y = 10(3) + 3.95 = 33.95$;
 $y = 10(5) + 3.95 = 53.95$; $y = 10(7) + 3.95 = 73.95$;
 $y = 10(10) + 3.95 = 103.95$.

Extension Activity

Write an ordered pair on the board. Have five students come to the front. The first student must write an ordered pair that could be in a function with the first ordered pair. The following students continue to write ordered pairs, being aware that their ordered pair must fit in a function with all the previous pairs. Have another five students come to the front and write ordered pairs that would not be in the function. Students should explain why their ordered pairs are not a part of the function. Discuss as a class as necessary.