4-4 Graphing a Function Rule

Common Core State Standards

F-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes . . . **Also N-Q.A.1, A-REI.D.10**

MP 1, MP 2, MP 3, MP 4

Objective To graph equations that represent functions

You get to choose the information you use!

MATHEMATICAL PRACTICES

SOLVE IT!

Getting Ready!

You are paying to print pictures from your digital camera at the photo shop. You choose one size for all your prints. What is one possible graph of the relationship between the total cost and the number of pictures you print?

Lesson Vocabulary
- continuous graph
- discrete graph

You can use a table of values to help you make a graph in the Solve It.

Essential Understanding The set of all solutions of an equation forms the equation's graph. A graph may include solutions that do not appear in a table. A real-world graph should only show points that make sense in the given situation.

Problem 1 Graphing a Function Rule

What is the graph of the function rule $y = -2x + 1$?

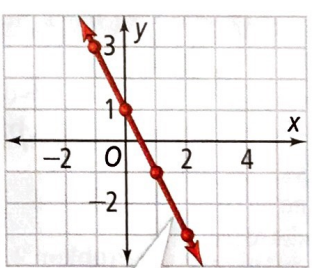
Think

What input values make sense here?
It is possible to use any input x in the equation and get an output y. Choose integer values of x to produce integer values of y, which are easier to graph.

Step 1 Make a table of values.

x	$y = -2x + 1$	(x, y)
-1	$y = -2(-1) + 1 = 3$	$(-1, 3)$
0	$y = -2(0) + 1 = 1$	$(0, 1)$
1	$y = -2(1) + 1 = -1$	$(1, -1)$
2	$y = -2(2) + 1 = -3$	$(2, -3)$

Step 2 Graph the ordered pairs.



Connect the points with a line to represent *all* solutions.

Got It? 1. What is the graph of the function rule $y = \frac{1}{2}x - 1$?

When you graph a real-world function rule, choose appropriate intervals for the units on the axes. Every interval on an axis should represent the same change in value. If all the data are nonnegative, show only the first quadrant.

Problem 2 Graphing a Real-World Function Rule

Plan

How do you choose values for a real-world independent variable?
Look for information about what the values can be. The independent variable c in this problem is limited by the capacity of the truck, 200 ft^3.

Trucking The function rule $W = 146c + 30{,}000$ represents the total weight W, in pounds, of a concrete mixer truck that carries c cubic feet of concrete. If the capacity of the truck is about 200 ft^3, what is a reasonable graph of the function rule?

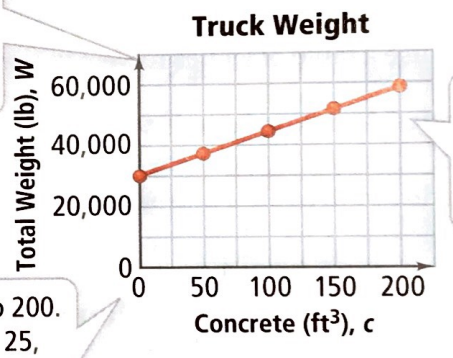
Step 1
Make a table to find ordered pairs (c, W).

The truck can hold 0 to 200 ft^3 of concrete. So only c-values from 0 to 200 are reasonable.

c	$W = 146c + 30{,}000$	(c, W)
0	$W = 146(0) + 30{,}000 = 30{,}000$	(0, 30,000)
50	$W = 146(50) + 30{,}000 = 37{,}300$	(50, 37,300)
100	$W = 146(100) + 30{,}000 = 44{,}600$	(100, 44,600)
150	$W = 146(150) + 30{,}000 = 51{,}900$	(150, 51,900)
200	$W = 146(200) + 30{,}000 = 59{,}200$	(200, 59,200)

Step 2
Graph the ordered pairs from the table.

W reaches almost 60,000 lb. So W-values from 0 to 60,000 in grid increments of 10,000 make sense.



All c-values from 0 to 200 make sense, so connect the points. Stop at 200 ft^3, the capacity of the truck.

The c-values go from 0 to 200. 200 is evenly divisible by 25, so use grid increments of 25.

Got It? **2. a.** The function rule $W = 8g + 700$ represents the total weight W, in pounds, of a spa that contains g gallons of water. What is a reasonable graph of the function rule, given that the capacity of the spa is 250 gal?

b. Reasoning What is the weight of the spa when empty? Explain.

In Problem 2, the truck could contain any amount of concrete from 0 to 200 ft^3, such as 27.3 ft^3 or $105\frac{2}{3}$ ft^3. You can connect the data points from the table because any point between the data points has meaning.

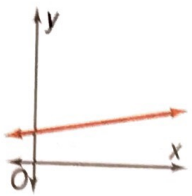
Some graphs may be composed of isolated points. For example, in the Solve It you graphed only points that represent printing whole numbers of photos.

Take note

Key Concept Continuous and Discrete Graphs

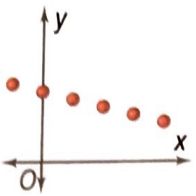
Continuous Graph

A **continuous graph** is a graph that is unbroken.



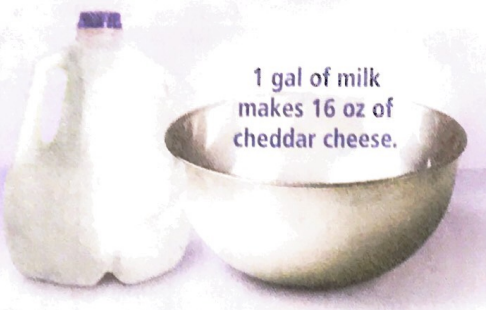
Discrete Graph

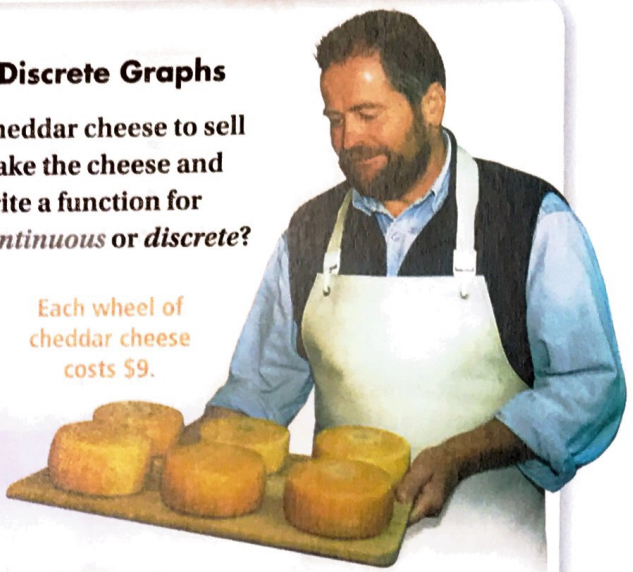
A **discrete graph** is composed of distinct, isolated points.



Problem 3 Identifying Continuous and Discrete Graphs

Farmer's Market **A local cheese maker is making cheddar cheese to sell at a farmer's market. The amount of milk used to make the cheese and the price at which he sells the cheese are shown. Write a function for each situation. Graph each function. Is the graph *continuous* or *discrete*?**



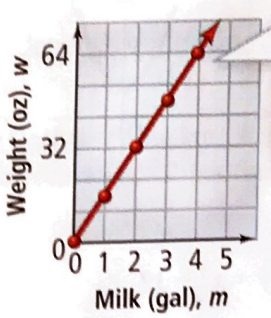


The weight w of cheese, in ounces, depends on the number of gallons m of milk used. So $w = 16m$. Make a table of values.

m	0	1	2	3	4
w	0	16	32	48	64

Graph each ordered pair (m, w).

Weight of Cheese



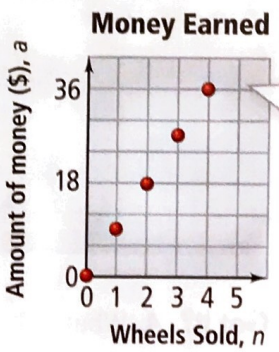
Any amount of milk makes sense, so connect the points. The graph is continuous.

The amount a of money made from selling cheese depends on the number n of wheels sold. So $a = 9n$. Make a table of values.

n	0	1	2	3	4
a	0	9	18	27	36

Graph each ordered pair (n, a)

Money Earned



He can only sell whole wheels of cheese. The graph is discrete.

Think

How can you decide if a graph is continuous or discrete?

Decide what values are reasonable for the independent variable. For example, if 3 and 4 make sense, do 3.3 and 3.7 make sense as well?

Got It? **3.** Graph each function rule. Is the graph *continuous* or *discrete*? Justify your answer.

a. The amount of water w in a wading pool, in gallons, depends on the amount of time t, in minutes, the wading pool has been filling, as related by the function rule $w = 3t$.

b. The cost C for baseball tickets, in dollars, depends on the number n of tickets bought, as related by the function rule $C = 16n$.

The function rules graphed in Problems 1–3 represent linear functions. You can also graph a nonlinear function rule. When a function rule does not represent a real-world situation, graph it as a continuous function.

Problem 4 Graphing Nonlinear Function Rules

What is the graph of each function rule?

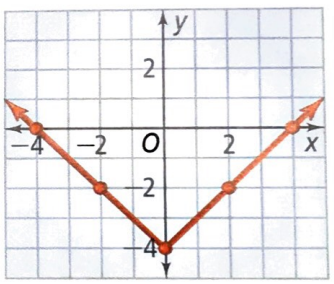
A $y = |x| - 4$

Step 1
Make a table of values.

Think
What input values make sense for these nonlinear functions?
Include 0 as well as negative and positive values so that you can see how the graphs change.

x	$y = \|x\| - 4$	(x, y)
-4	$y = \|-4\| - 4 = 0$	$(-4, 0)$
-2	$y = \|-2\| - 4 = -2$	$(-2, -2)$
0	$y = \|0\| - 4 = -4$	$(0, -4)$
2	$y = \|2\| - 4 = -2$	$(2, -2)$
4	$y = \|4\| - 4 = 0$	$(4, 0)$

Step 2
Graph the ordered pairs. Connect the points.

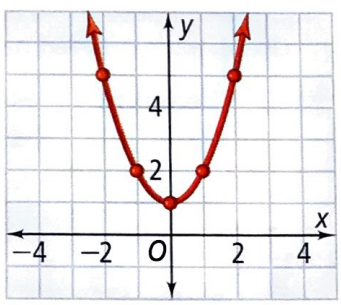


B $y = x^2 + 1$

Step 1
Make a table of values.

x	$y = x^2 + 1$	(x, y)
-2	$y = (-2)^2 + 1 = 5$	$(-2, 5)$
-1	$y = (-1)^2 + 1 = 2$	$(-1, 2)$
0	$y = 0^2 + 1 = 1$	$(0, 1)$
1	$y = 1^2 + 1 = 2$	$(1, 2)$
2	$y = 2^2 + 1 = 5$	$(2, 5)$

Step 2
Graph the ordered pairs. Connect the points.



Got It? **4.** What is the graph of the function rule $y = x^3 + 1$?

Lesson Check

Do you know HOW?

Graph each function rule.

1. $y = 2x + 4$
2. $y = \frac{1}{2}x - 7$
3. $y = 9 - x$
4. $y = -x^2 + 2$

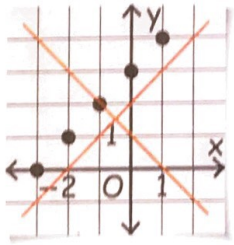
5. The function rule $h = 18 + 1.5n$ represents the height h, in inches, of a stack of traffic cones.
   a. Make a table for the function rule.
   b. Suppose the stack of cones can be no taller than 30 in. What is a reasonable graph of the function rule?

Do you UNDERSTAND? MATHEMATICAL PRACTICES

Vocabulary Tell whether each relationship should be represented by a *continuous* or a *discrete* graph.

6. The number of bagels b remaining in a dozen depends on the number s that have been sold.
7. The amount of gas g remaining in the tank of a gas grill depends on the amount of time t the grill has been used.

8. **Error Analysis** Your friend graphs $y = x + 3$ at the right. Describe and correct your friend's error.



Practice and Problem-Solving Exercises MATHEMATICAL PRACTICES

A Practice Graph each function rule. See Problem 1.

9. $y = x - 3$
10. $y = 2x + 5$
11. $y = 3x - 2$
12. $y = 5 + 2x$
13. $y = 3 - x$
14. $y = -5x + 12$
15. $y = 10x$
16. $y = 4x - 5$
17. $y = 9 - 2x$
18. $y = 2x - 1$
19. $y = \frac{3}{4}x + 2$
20. $y = -\frac{1}{2}x + \frac{1}{2}$

Graph each function rule. Explain your choice of intervals on the axes of the graph. Tell whether the graph is *continuous* or *discrete*. See Problems 2 and 3.

21. **Beverages** The height h, in inches, of the juice in a 20-oz bottle depends on the amount of juice j, in ounces, that you drink. This situation is represented by the function rule $h = 6 - 0.3j$.
22. **Trucking** The total weight w, in pounds, of a tractor-trailer capable of carrying 8 cars depends on the number of cars c on the trailer. This situation is represented by the function rule $w = 37{,}000 + 4200c$.
23. **Food Delivery** The cost C, in dollars, for delivered pizza depends on the number p of pizzas ordered. This situation is represented by the function rule $C = 5 + 9p$.

See Problem 4.

Graph each function rule.

24. $y = |x| - 7$

25. $y = |x| + 2$

26. $y = 2|x|$

27. $y = x^3 - 1$

28. $y = 3x^3$

29. $y = -2x^2$

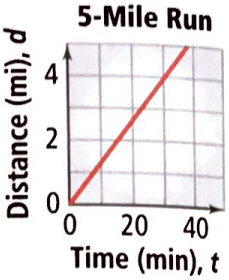
30. $y = |-2x| - 1$

31. $y = -x^3$

32. $y = |x - 3| - 1$

B Apply

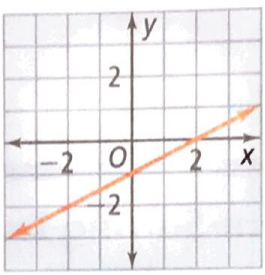
33. Error Analysis The graph at the right shows the distance d you run, in miles, as a function of time t, in minutes, during a 5-mi run. Your friend says that the graph is not continuous because it stops at $d = 5$, so the graph is discrete. Do you agree? Explain.



34. Writing Is the point $\left(2, 2\frac{1}{2}\right)$ on the graph of $y = x + 2$? How do you know?

35. Geometry The area A of an isosceles right triangle depends on the length ℓ of each leg of the triangle. This is represented by the rule $A = \frac{1}{2}\ell^2$. Graph the function rule. Is the graph *continuous* or *discrete*? How do you know?

36. Which function rule is graphed below?



(A) $y = -\frac{1}{2}x + 1$

(B) $y = \frac{1}{2}x - 1$

(C) $y = \left|\frac{1}{2}x\right| - 1$

(D) $y = \frac{1}{2}x + 1$

37. Sporting Goods The amount a basketball coach spends at a sporting goods store depends on the number of basketballs the coach buys. The situation is represented by the function rule $a = 15b$.

a. Make a table of values and graph the function rule. Is the graph *continuous* or *discrete*? Explain.

b. Suppose the coach spent \$120 before tax. How many basketballs did she buy?

38. Think About a Plan The height h, in inches, of the vinegar in the jars of pickle chips shown at the right depends on the number of chips p you eat. About how many chips must you eat to lower the level of the vinegar in the jar on the left to the level of the jar on the right? Use a graph to find the answer.

$h = 4.75 - 0.22p$

- What should the maximum value of p be on the horizontal axis?
- What are reasonable values of p in this situation?

STEM **39. Falling Objects** The height h, in feet, of an acorn that falls from a branch 100 ft above the ground depends on the time t, in seconds, since it has fallen. This is represented by the rule $h = 100 - 16t^2$. About how much time does it take for the acorn to hit the ground? Use a graph and give an answer between two consecutive whole-number values of t.

Challenge

40. Reasoning Graph the function rules below in the same coordinate plane.

$y = |x| + 1$ $y = |x| + 4$ $y = |x| - 3$

In the function rule $y = |x| + k$, how does changing the value of k affect the graph?

41. Reasoning Make a table of values and a graph for the function rules $y = 2x$ and $y = 2x^2$. How does the value of y change when you double the value of x for each function rule?

Apply What You've Learned

MATHEMATICAL PRACTICES
MP 4

In the Apply What You've Learned in Lesson 4-2, you identified the relationship shown in Jayden's blog table as a function, and you wrote a function modeling the relationship. Now look at the function on page 233 modeling the number of subscribers to Keiko's blog.

a. Make a table of values for the function that models the number of subscribers to Keiko's blog, $K = m^2 + 10$, and graph the ordered pairs from the table.

b. Graph the ordered pairs using the data about Jayden's blog, shown again below.

Jayden's Blog

Number of Months	Number of Subscribers
0	48
1	56
2	64
3	72
4	80