

Compare Linear and Nonlinear Functions

Let's Build

Lesson 3-3

I can ... compare linear and nonlinear functions.

Explore and Share

Two media streaming services offer family plans with different monthly costs, as shown in the ads. What do the two plans have in common? How are they different? When is Media4You a better deal than Family Stream?



Model with Math How can you represent the relationship between cost and number of users?

Look for Relationships Describe the relationship between the cost and the number of users for each service. What do you notice about each relationship?



Visual Learning

Example 1 Compare Two Linear Functions

An auto assembly factory needs to purchase new welding robots. The factory manager has information on two different models of welding robots. The welding rates for each model are shown. How do the welding rates for the two robots compare?



Look for Relationships What properties of functions can be used to compare functions?

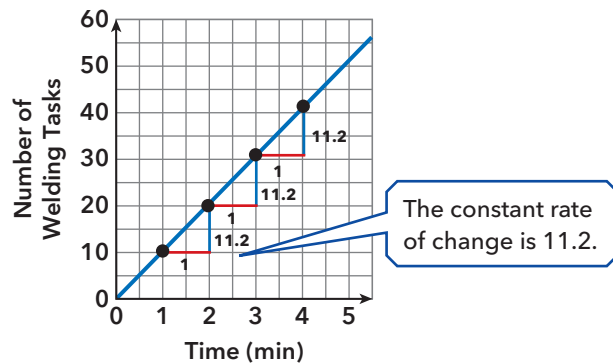
STEP 1

Find the welding rate, or the constant rate of change, for each robot.

Model T1000

Time (minutes)	Number of Welding Tasks
2	20.8
5	52
7	72.8
12	124.8

Model GNX007



$$\frac{52 - 20.8}{5 - 2} = \frac{31.2}{3} = 10.4$$

The constant rate of change is 10.4.

STEP 2

Find the initial value for each robot.

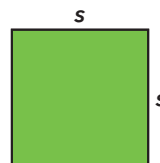
At 0 minutes, each robot has performed 0 tasks, so the initial value is 0.

The data for the model GXN007 robot has a greater constant rate of change, or welding rate, so it can complete more welding tasks per minute than the Model T1000 robot.

Try It! The welding rate of a third robot is represented by the equation $t = 10.8w$, where t represents the time in minutes and w represents the number of welding tasks. How does it compare to the other two?

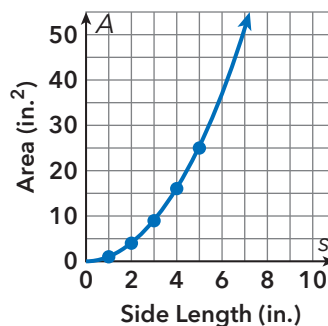
Example 2 Compare a Linear and a Nonlinear Function

A square with side length s is shown. The table shows the relationship between the side length and perimeter as the side length increases. The graph shows the relationship between the side length and area. How do the two relationships compare?



	Side Length, s (in.)	Perimeter, P (in.)
	0	0
+1	1	4
+1	2	8
+1	3	12
+1	4	16

This relation is a function. It has a constant rate of change. It is a *linear* function.



This relation is a function, but it does not have a constant rate of change. It is a *nonlinear* function.

Both relationships are functions. Both perimeter and area are functions of side length.

Example 3 Compare Properties of Linear Functions

Compare the properties of the two functions.

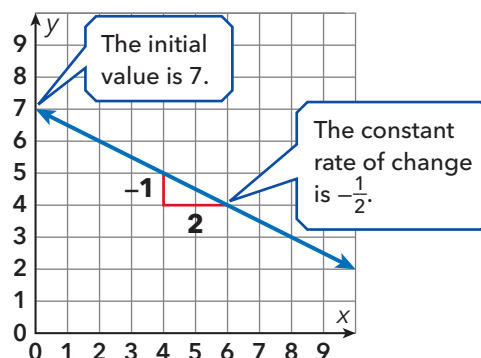
Function A

The constant rate of change is 2.

$$y = 2x - 3$$

The initial value is -3 .

Function B



Function A has a greater rate of change. Function B has a greater initial value.

Try It! Compare the properties of these two linear functions.

Function 1

x	2	5	9	11	14
y	1	5.5	11.5	14.5	19

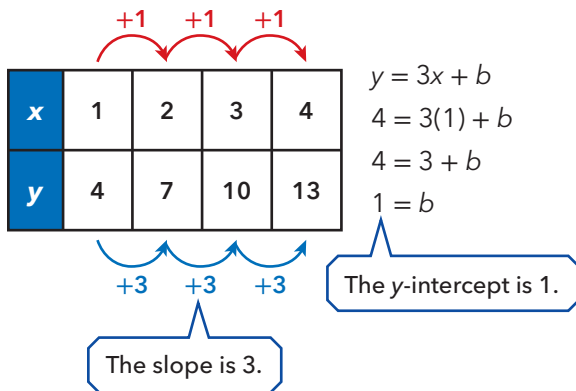
Function 2

$$y = 2x - 4$$

Key Concept

You can compare functions in different representations by using the properties of functions.

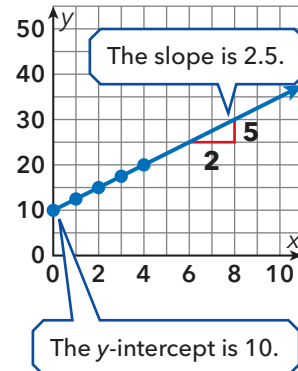
Compare the constant rate of change and the initial value.



The slope is $\frac{2}{3}$.

$$y = \frac{2}{3}x - 4$$

The y-intercept is -4.



Talk About Math Ideas

How do different representations of functions help you determine whether a function is linear or non-linear?

Do You Understand?

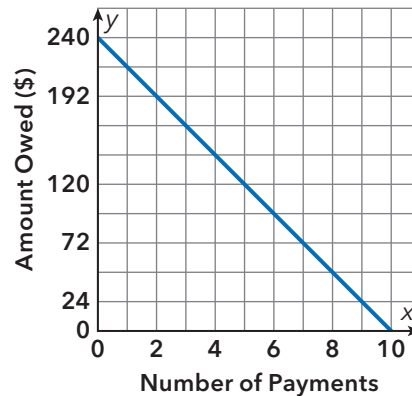
- Essential Question** How can you compare two functions?
- Reasoning** Anne is running on a trail at an average speed of 6 miles per hour beginning at mile marker 4. John is running on the same trail at a constant speed, shown in the table. Who is running faster? Explain.

Time (hours), x	0	0.5	1	1.5
Mile Marker, y	1	4.5	8	11.5

- Reasoning** In Item 2, how do Anne and John's starting positions compare? Explain.

Do You Know How?

Felipe and Samantha use a payment plan to buy musical instruments. Felipe writes the equation $y = -30x + 290$ to represent the amount he owes, y , after x payments. The graph shows how much Samantha owes after each payment.

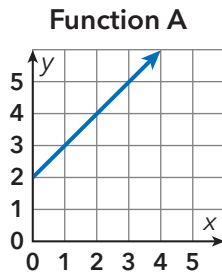


- Whose musical instrument costs more? Explain.
- Who will pay more each month? Explain.



Practice and Problem Solving

6. Two linear functions are shown. Which function has the greater rate of change?



Function B

x	y
0	0
2	3
4	6
6	9

7. Two linear functions are shown. Which function has the greater initial value?

Function A

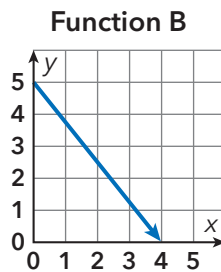
x	y
-1	6
0	4
1	2
2	0

Function B
 $y = 7x + 3$

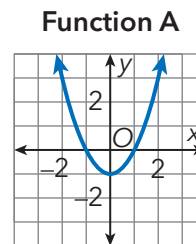
8. Is each function *linear* or *nonlinear*?

Function A

x	y
0	1
1	2
2	5
3	10

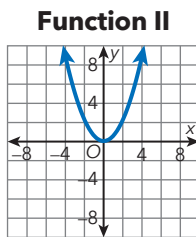
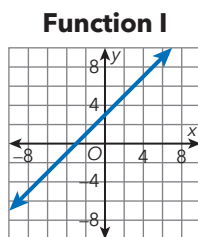


9. Is each function *linear* or *nonlinear*?



Function B
 $y = x$

10. Determine whether each function is *linear* or *nonlinear* from its graph.



11. **Look for Relationships** Justin opens a savings account with \$4. He saves \$2 each week. Does a linear function or a nonlinear function represent this situation? Explain.

Justin's Savings Account

Week	0	1	2	3	4	5
Money in Account	4	6	8	10	12	14

12. **Reasoning** The function $y = 4x + 3$ describes Player A's scores in a game of trivia, where x is the number of questions answered correctly and y is the score. The function represented in the table shows Player B's scores. What do the rates of change tell you about how each player earns points?

Player B's Trivia Scores

Correct Answers	Score
1	4
2	5
3	6
4	7

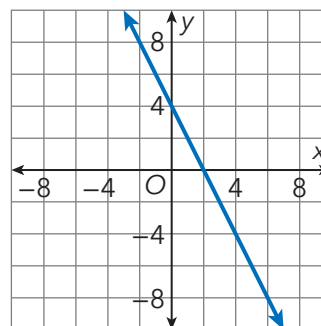
13. Two athletes are training over a two-week period to increase the number of push-ups each can do consecutively. Athlete A can do 16 push-ups to start, and increases his total by 2 each day. Athlete B's progress is charted in the table. Compare the initial values for each. What does the initial value mean in this situation?

Athlete B Push-up Progress

Day	Number of Push-ups
0	12
1	15
2	18
2	21

14. **Higher Order Thinking** The equation $y = 4x - 2$ and the table and graph shown describe three different linear functions. Which function has the greatest rate of change? Which has the least? Explain.

x	y
1	5
2	10
3	15
4	20



Assessment Practice

15. Elijah has 2 cats and 2 dogs. He finds that he uses 3 cups of dog food to feed his dogs each day. After 12 days he has about 84 cups of dog food left. The table shows the amount of cat food remaining from feeding the cats after different amounts of time. Which animals consumed their food at a faster rate?

Time Elapsed (days)	Cups of Cat Food
6	48
8	44
12	36
14	32

16. The height of a burning candle can be modeled by a linear function. Candle A has an initial height of 201 millimeters, and its height decreases to 177 millimeters after 4 hours of burning. The height, h , in millimeters, of Candle B can be modeled by the function $h = 290 - 5t$, where t is the time in hours. Which of the following statements are true?

- ☐ The initial height of Candle A is greater than the initial height of Candle B.
- ☐ The height of Candle A decreases at a faster rate than the height of Candle B.
- ☐ Candle B will burn out in 58 hours.
- ☐ After 10 hours, the height of Candle A is 110 millimeters.
- ☐ Candle A will burn out before Candle B.