1-2 Introduction to Parent Functions

Warm Up

Lesson Presentation

Lesson Quiz

Warm Up

1. For the power 3^5, identify the exponent and the base. exponent: 5; base: 3

Evaluate.

2. $\left(\frac{2}{3}\right)^{-2}$ $\frac{9}{4}$

3. $f(9)$ when $f(x) = 2x + \sqrt{x}$ 21

Objectives

Identify parent functions from graphs and equations.

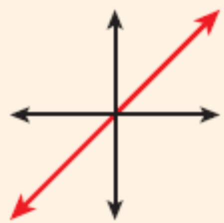
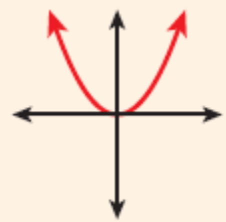
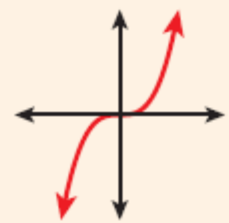
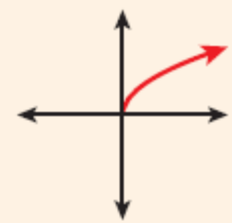
Use parent functions to model real-world data and make estimates for unknown values.

Vocabulary

parent function

Similar to the way that numbers are classified into sets based on common characteristics, functions can be classified into *families of functions*. The **parent function** is the simplest function with the defining characteristics of the family. Functions in the same family are transformations of their parent function.

Parent Functions

Family	Constant	Linear	Quadratic	Cubic	Square root
Rule	$f(x) = c$	$f(x) = x$	$f(x) = x^2$	$f(x) = x^3$	$f(x) = \sqrt{x}$
Graph					
Domain	$\mathbb{R}$	$\mathbb{R}$	$\mathbb{R}$	$\mathbb{R}$	$x \geq 0$
Range	$y = c$	$\mathbb{R}$	$y \geq 0$	$\mathbb{R}$	$y \geq 0$
Intersects y-axis	$(0, c)$	$(0, 0)$	$(0, 0)$	$(0, 0)$	$(0, 0)$

Helpful Hint

To make graphs appear accurate on a graphing calculator, use the standard square window. Press ZOOM, choose **6:ZStandard**, press ZOOM again, and choose **5:ZSquare**.

Example 1A: Identifying Transformations of Parent Functions

Identify the parent function for *g* from its function rule. Then graph *g* on your calculator and describe what transformation of the parent function it represents.

$g(x) = x - 3$

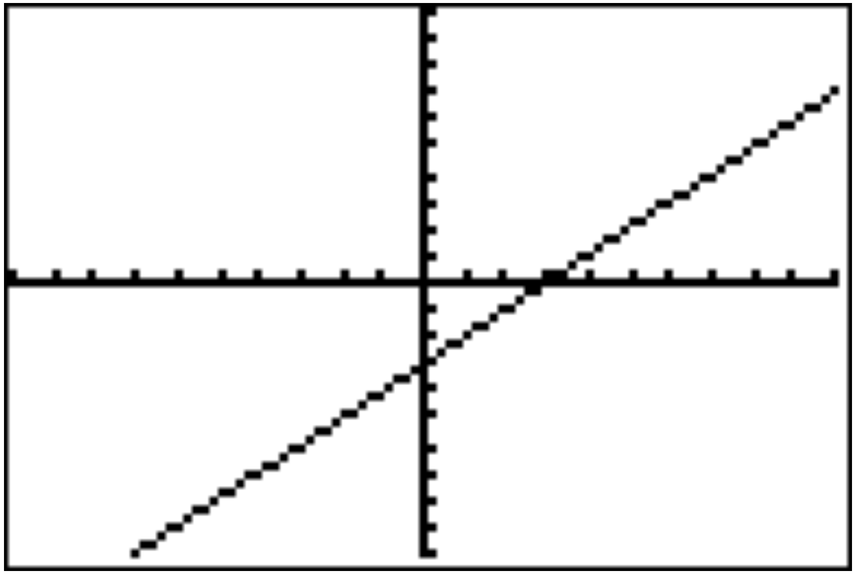
$g(x) = x - 3$ is linear

x has a power of 1.

The linear parent function $f(x) = x$ intersects the *y*-axis at the point (0, 0).

Graph $\mathbf{Y_1 = x - 3}$ on the graphing calculator. The function $g(x) = x - 3$ intersects the *y*-axis at the point (0, –3).

So $g(x) = x - 3$ represents a vertical translation of the linear parent function 3 units down.



Example 1B: Identifying Transformations of Parent Functions

Identify the parent function for *g* from its function rule. Then graph on your calculator and describe what transformation of the parent function it represents.

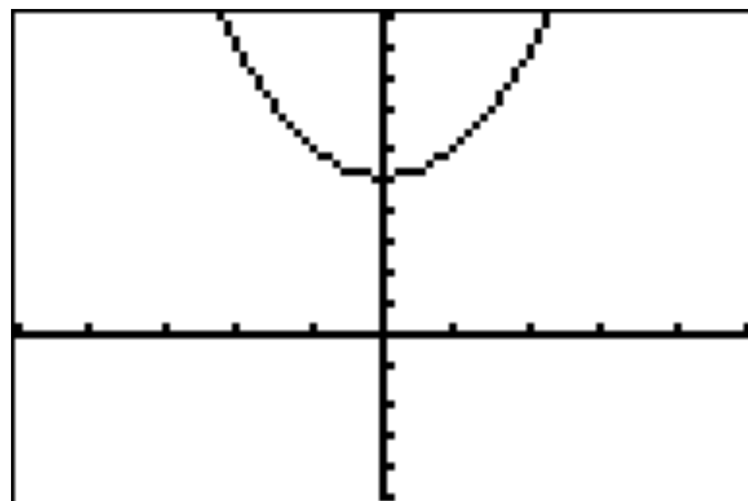
$\mathbf{g(x) = x^2 + 5}$

$g(x) = x^2 + 5$ is quadratic. *x has a power of 2.*

The quadratic parent function $f(x) = x$ intersects the *y*-axis at the point (0, 0).

Graph $\mathbf{Y_1 = x^2 + 5}$ on a graphing calculator. The function $g(x) = x^2 + 5$ intersects the y-axis at the point (0, 5).

So $g(x) = x^2 + 5$ represents a vertical translation of the quadratic parent function 5 units up.



Check It Out! Example 1a

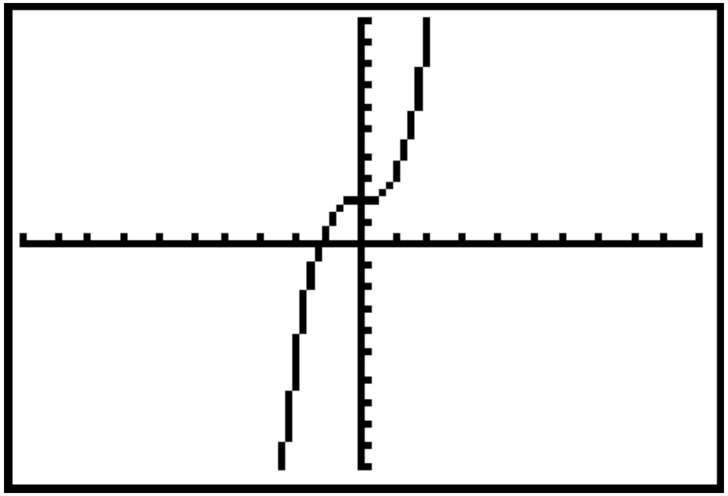
Identify the parent function for *g* from its function rule. Then graph on your calculator and describe what transformation of the parent function it represents.

$$\boldsymbol{g(x) = x^3 + 2}$$

$g(x) = x^3 + 2$ is cubic. *x has a power of 3.*

The cubic parent function $f(x) = x^3$ intersects the y-axis at the point (0, 0).

Graph $\mathbf{Y_1 = x^3 + 2}$ on a graphing calculator. The function $g(x) = x^3 + 2$ intersects the y-axis at the point (0, 2).



So $g(x) = x^3 + 2$ represents a vertical translation of the quadratic parent function 2 units up.

Check It Out! Example 1b

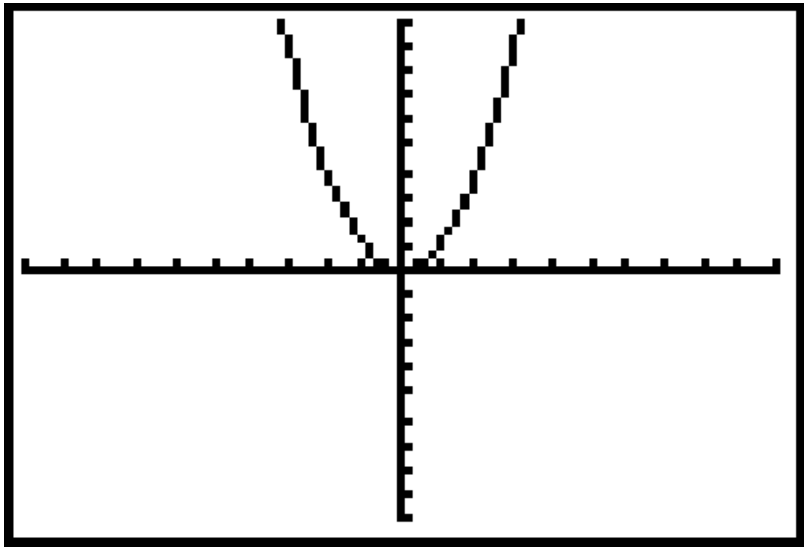
Identify the parent function for *g* from its function rule. Then graph on your calculator and describe what transformation of the parent function it represents.

$$g(x) = (-x)^2$$

$g(x) = (-x)^2$ is quadratic. *x has a power of 2.*

The quadratic parent function $f(x) = x^2$ intersects the *y*-axis at the point (0, 0).

Graph $\mathbf{Y_1 = (-x)^2}$ on a graphing calculator. The function $g(x) = (-x)^2$ intersects the *y*-axis at the point (0, 0).



So $g(x) = (-x)^2$ represents a reflection across the *y*-axis of the quadratic parent function.

It is often necessary to work with a set of data points like the ones represented by the table below.

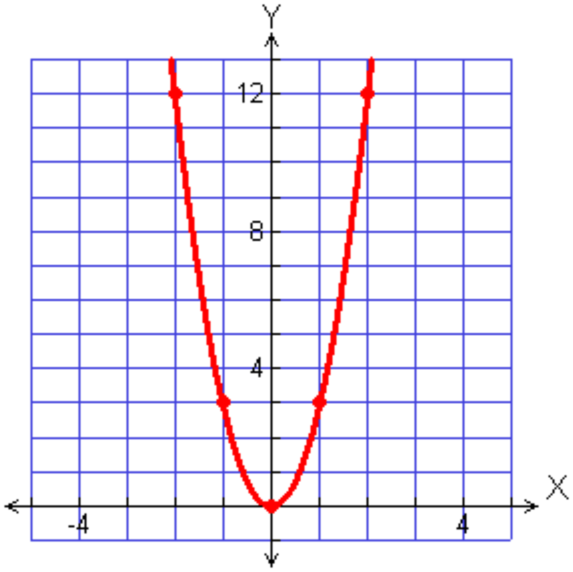
x	−4	−2	0	2	4
y	8	2	0	2	8

With only the information in the table, it is impossible to know the exact behavior of the data between and beyond the given points. However, a working knowledge of the parent functions can allow you to sketch a curve to approximate those values not found in the table.

Example 2: Identifying Parent Functions to Model Data Sets

Graph the data from this set of ordered pairs. Describe the parent function and the transformation that best approximates the data set. {(–2, 12), (–1, 3), (0, 0), (1, 3), (2, 12)}

x	–2	–1	0	1	2
y	12	3	0	3	12



The graph of the data points resembles the shape of the quadratic parent function $f(x) = x^2$.

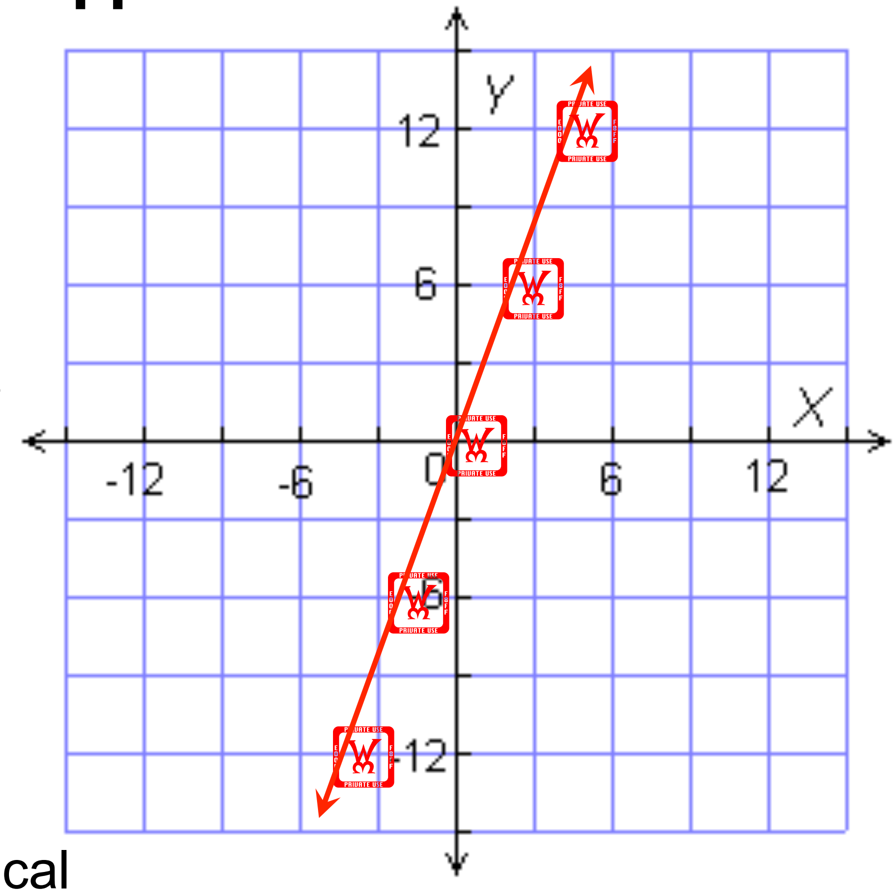
The quadratic parent function passes through the points (1, 1) and (2, 4). The data set contains the points (1, 1) = (1, 3(1)) and (2, 4) = (2, 3(4)).

The data set seems to represent a vertical stretch of the quadratic parent function by a factor of 3.

Check It Out! Example 2

Graph the data from the table. Describe the parent function and the transformation that best approximates the data set.

x	−4	−2	0	2	4
y	−12	−6	0	6	12

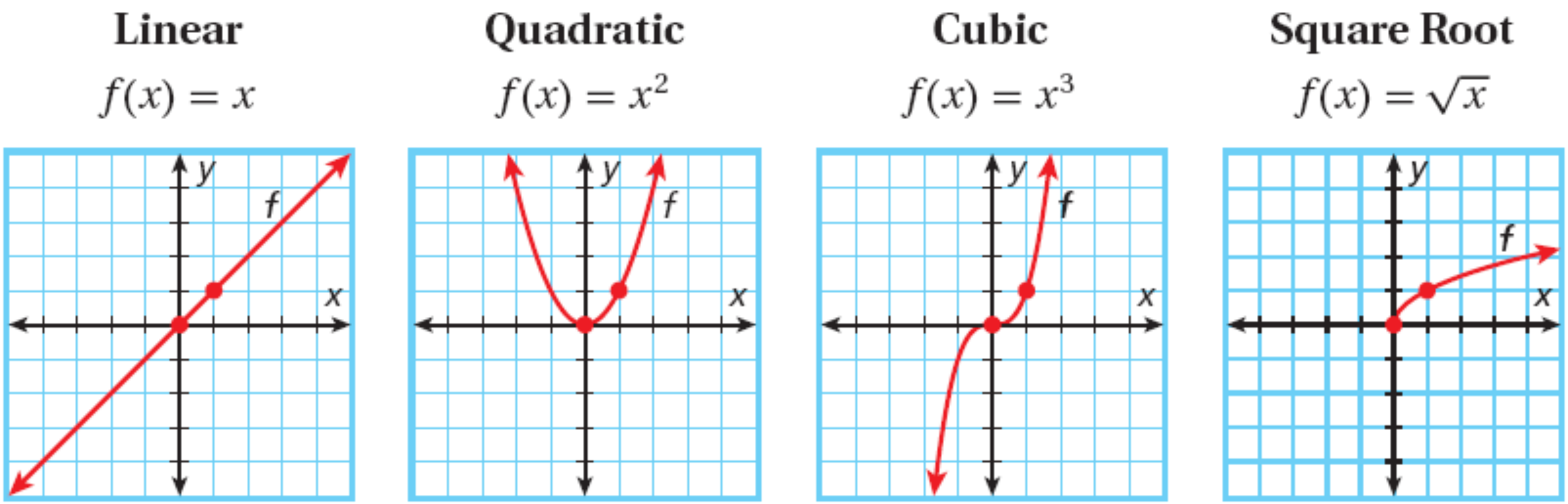


The graph of the data points resembles the shape of the linear parent function $f(x) = x$.

The linear parent function passes through the points (2, 2) and (4, 4). The data set contains the points (2, 2) = (2, 3(2)) and (4, 4) = (4, 3(4)).

The data set seems to represent a vertical stretch of the linear function by a factor of 3.

Consider the two data points (0, 0) and (0, 1). If you plot them on a coordinate plane you might very well think that they are part of a linear function. In fact they belong to each of the parent functions below.

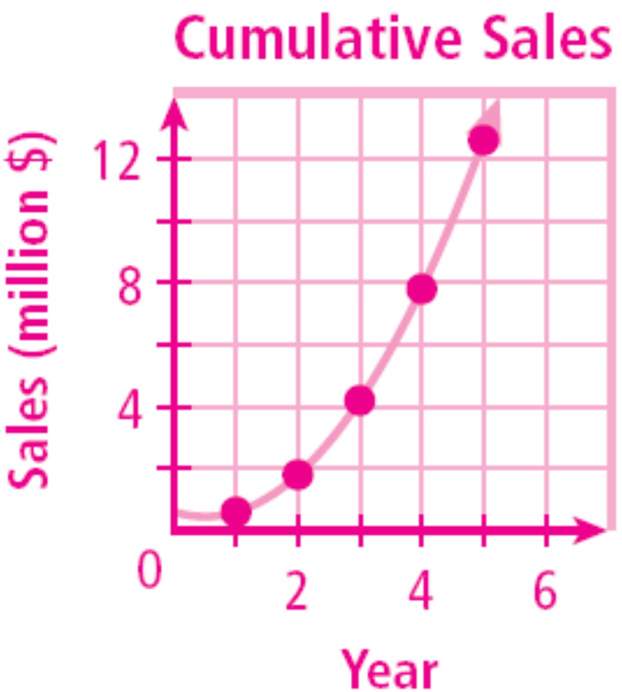


Remember that any parent function you use to approximate a set of data should never be considered exact. However, these function approximations are often useful for estimating unknown values.

Example 3: Application

Graph the relationship from year to sales in millions of dollars and identify which parent function best describes it. Then use the graph to estimate when cumulative sales reached $10 million.

Cumulative Sales	
Year	**Sales (million $)**
1	0.6
2	1.8
3	4.2
4	7.8
5	12.6



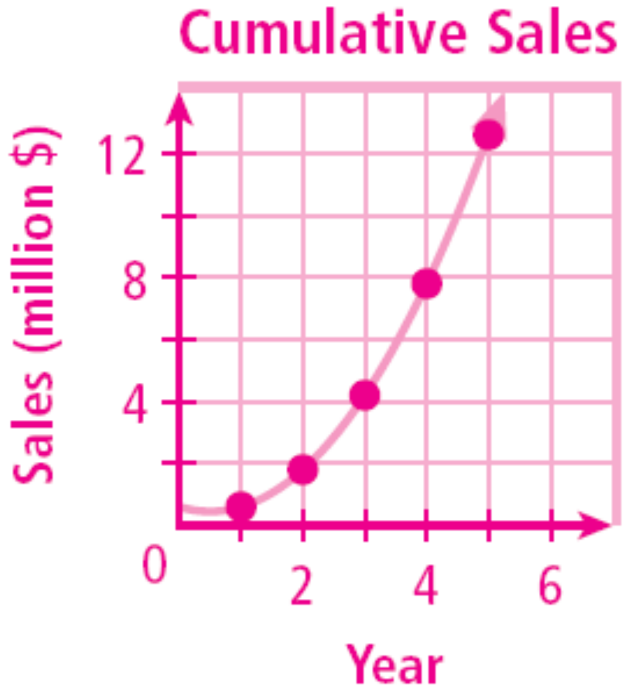
Step 1 Graph the relation.

Graph the points given in the table. Draw a smooth curve through them to help you see the shape.

Example 3 Continued

Step 2 Identify the parent function.

The graph of the data set resembles the shape of the quadratic parent function $f(x) = x^2$.



Step 3 Estimate when cumulative sales reached $10 million.

The curve indicates that sales will reach the $10 million mark after about 4.5 years.

Check It Out! Example 3

The cost of playing an online video game depends on the number of months for which the online service is used. Graph the relationship from number of months to cost, and identify which parent function best describes the data. Then use the graph to estimate the cost of 5 months of online service.

Cost of Online Video Game					
Time (mo)	1	3	6	9	12
Cost ($)	40	56	80	104	128

Check It Out! Example 3 Continued

Cost of Online Video Game					
Time (mo)	1	3	6	9	12
Cost ($)	40	56	80	104	128

Step 1 Graph the relation.

Graph the points given in the table. Draw a smooth line through them to help you see the shape.

Step 2 Identify the parent function.

The graph of the data set resembles the shape of a linear parent function $f(x) = x$.

Step 3 Estimate the cost for 5 months of online service.

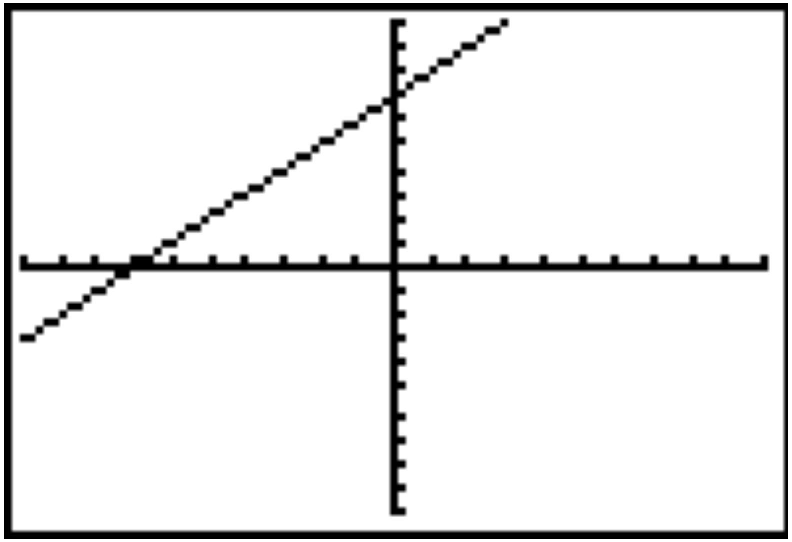
The linear graph indicates that the cost for 5 months of online service is $72.

Lesson Quiz: Part I

Identify the parent function for *g* from its function rule. Then graph *g* on your calculator and describe what transformation of the parent function it represents.

1. $g(x) = x + 7$

linear;
translation up 7 units

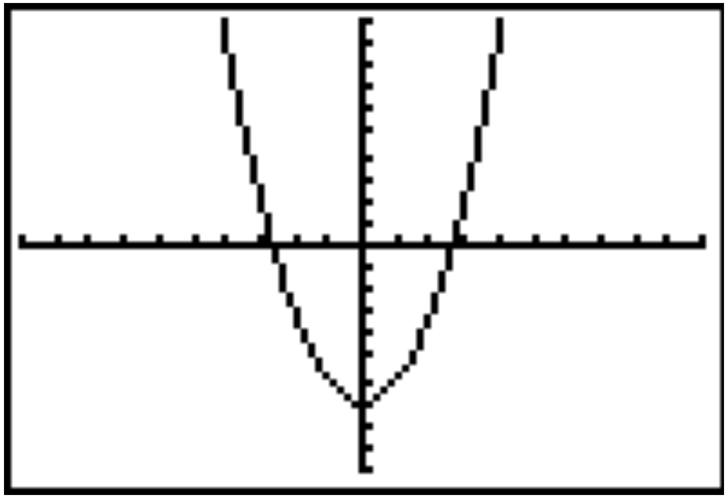


Lesson Quiz: Part II

Identify the parent function for *g* from its function rule. Then graph *g* on your calculator and describe what transformation of the parent function it represents.

2. $g(x) = x^2 - 7$

quadratic;
translation down 6 units



Lesson Quiz: Part III

3. Stacy earns \$7.50 per hour. Graph the relationship from hours to amount earned and identify which parent function best describes it. Then use the graph to estimate how many hours it would take Stacy to earn \$60.

linear: 8 hr