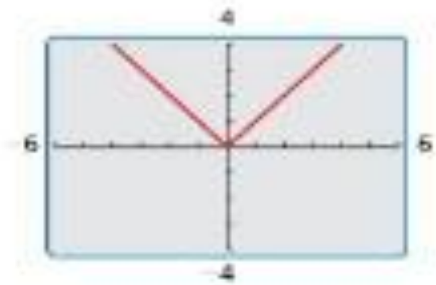
Chapter 1
Linear Functions

Section 1-1
Parent Functions and Transformations

EXPLORATION 1 Identifying Basic Parent Functions

Work with a partner. Graphs of eight basic parent functions are shown below. Classify each function as *constant*, *linear*, *absolute value*, *quadratic*, *square root*, *cubic*, *reciprocal*, or *exponential*. Justify your reasoning.

a.


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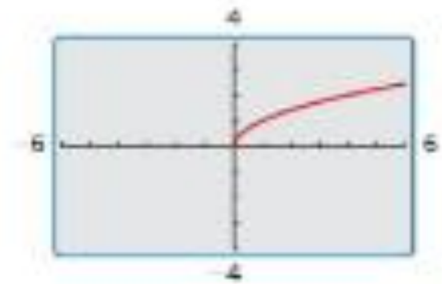

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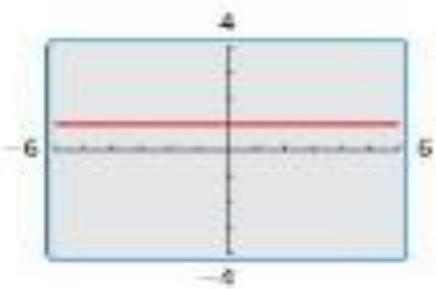

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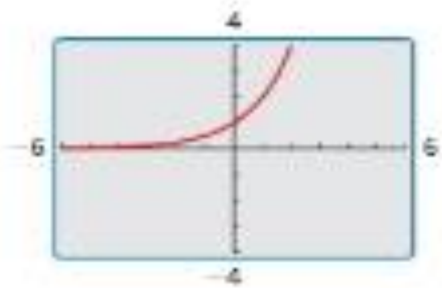

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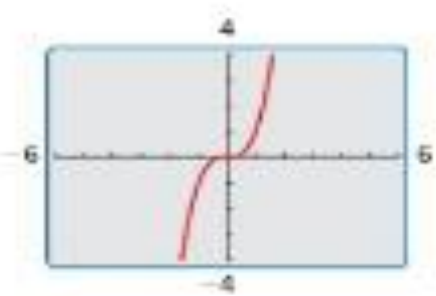

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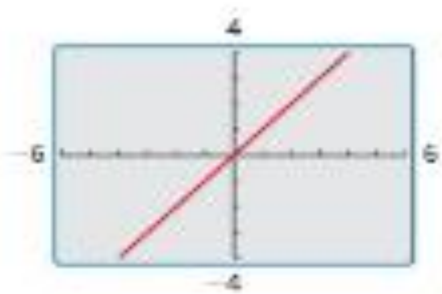

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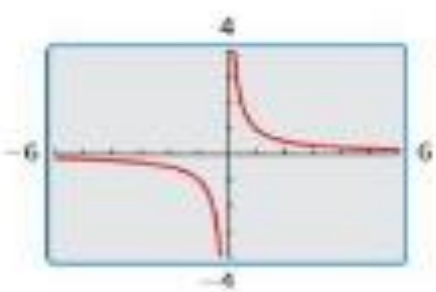

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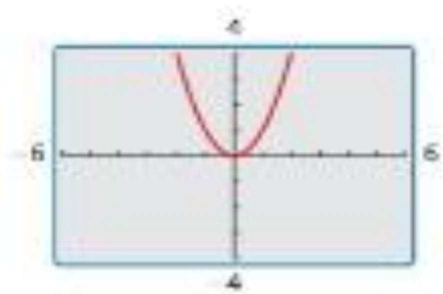
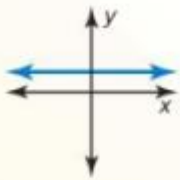
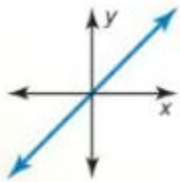
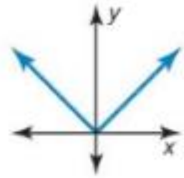
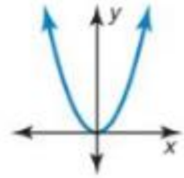


Core Concept

Parent Functions

Family	Constant	Linear	Absolute Value	Quadratic
Rule	$f(x) = 1$	$f(x) = x$	$f(x) = \lvert x \rvert$	$f(x) = x^2$
Graph				
Domain	All real numbers	All real numbers	All real numbers	All real numbers
Range	$y = 1$	All real numbers	$y \geq 0$	$y \geq 0$

Describing Transformations

A **transformation** changes the size, shape, position, or orientation of a graph.
A **translation** is a transformation that shifts a graph horizontally and/or vertically but does not change its size, shape, or orientation.

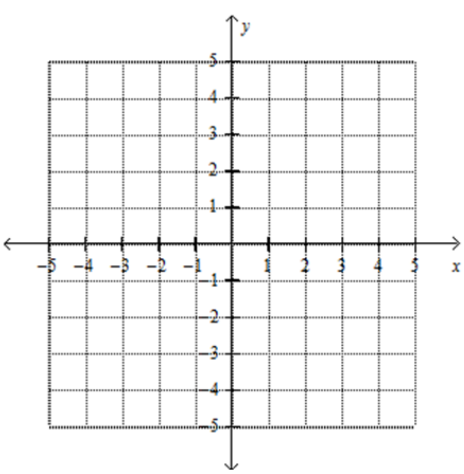
REMEMBER

Tutorial

The slope-intercept form of a linear equation is $y = mx + b$, where m is the slope and b is the y-intercept.

EXAMPLE 2 **Graphing and Describing Translations**

Graph $g(x) = x - 4$ and its parent function. Then describe the transformation.



X	Y

X	Y

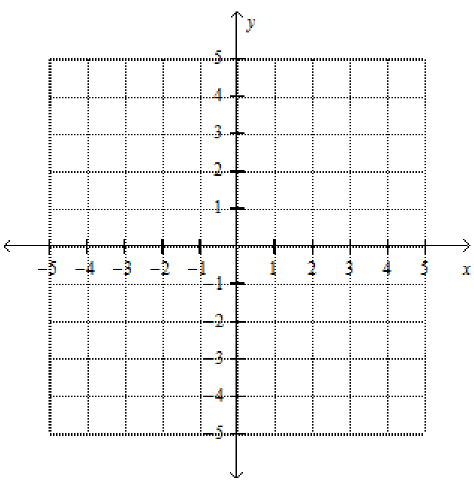
A **reflection** is a transformation that flips a graph over a line called the *line of reflection*. A reflected point is the same distance from the line of reflection as the original point but on the opposite side of the line.

REMEMBER

The function $p(x) = -x^2$ is written in *function notation*, where $p(x)$ is another name for y.

EXAMPLE 3 Graphing and Describing Reflections

Graph $p(x) = -x^2$ and its parent function. Then describe the transformation.

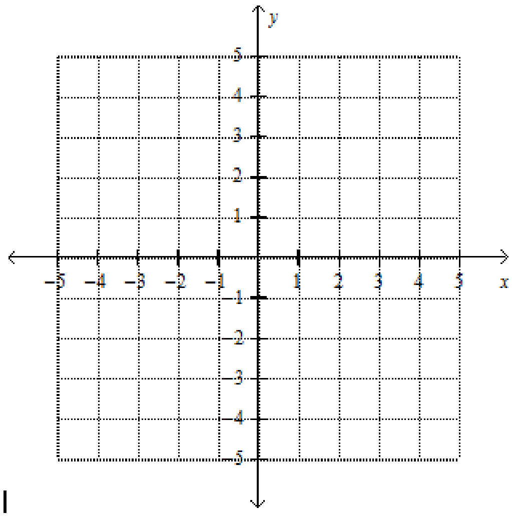


X	Y

X	Y

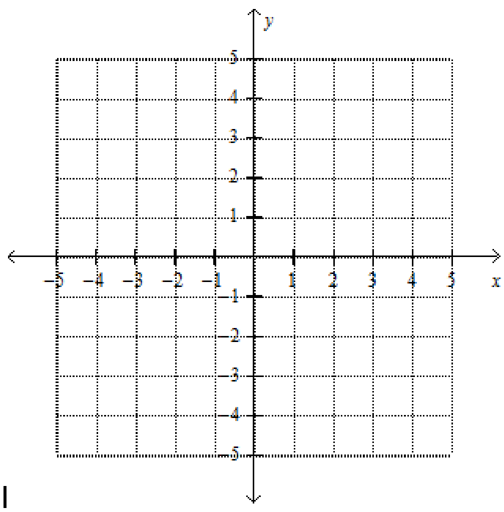
Graph the function and its parent function. Then describe the transformation.

2. $g(x) = x + 3$ **3.** $h(x) = (x - 2)^2$ **4.** $n(x) = -|x|$



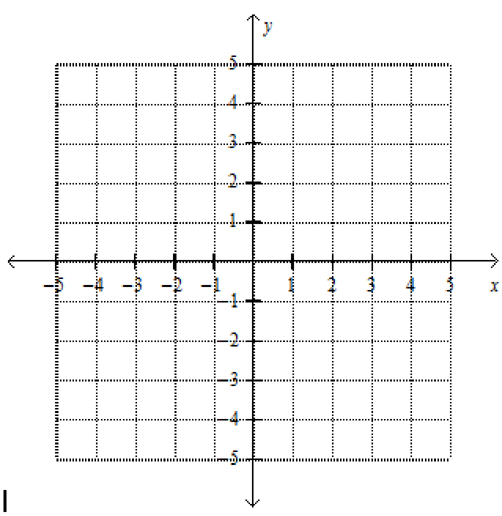
X	Y

X	Y



X	Y

X	Y



X	Y

X	Y

Another way to transform the graph of a function is to multiply all of the y-coordinates by the same positive factor (other than 1). When the factor is greater than 1, the transformation is a **vertical stretch**. When the factor is greater than 0 and less than 1, it is a **vertical shrink**.

Tutorial

EXAMPLE 4 Graphing and Describing Stretches and Shrinks

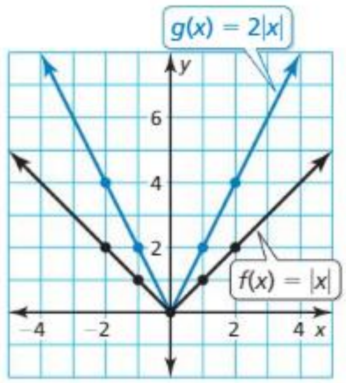
Graph each function and its parent function. Then describe the transformation.

a. $g(x) = 2|x|$ **b.** $h(x) = \frac{1}{2}x^2$

SOLUTION

a. The function g is an absolute value function. Use a table of values to graph the functions.

x	$y = \lvert x \rvert$	$y = 2\lvert x \rvert$
−2	2	4
−1	1	2
0	0	0
1	1	2
2	2	4

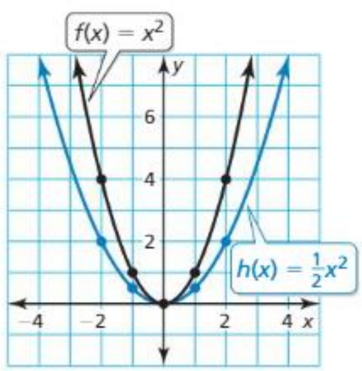


The y-coordinate of each point on g is two times the y-coordinate of the corresponding point on the parent function.

▶ So, the graph of $g(x) = 2|x|$ is a vertical stretch of the graph of the parent absolute value function.

b. The function h is a quadratic function. Use a table of values to graph the functions.

x	$y = x^2$	$y = \frac{1}{2}x^2$
−2	4	2
−1	1	$\frac{1}{2}$
0	0	0
1	1	$\frac{1}{2}$
2	4	2

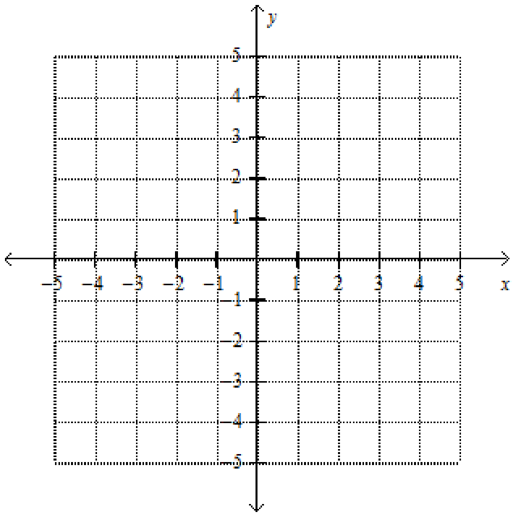


The y-coordinate of each point on h is one-half of the y-coordinate of the corresponding point on the parent function.

▶ So, the graph of $h(x) = \frac{1}{2}x^2$ is a vertical shrink of the graph of the parent quadratic function.

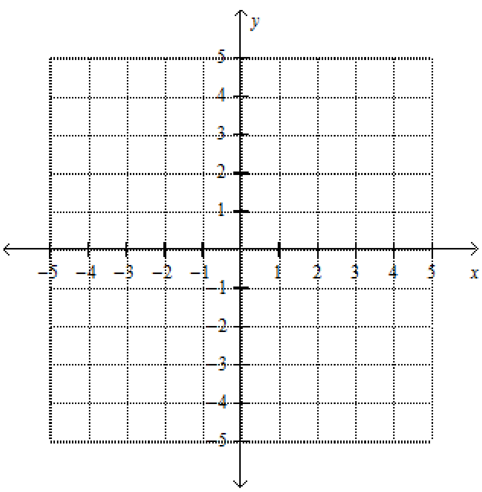
Graph the function and its parent function. Then describe the transformation.

5. $g(x) = 3x$ **6.** $h(x) = \frac{3}{2}x^2$ **7.** $c(x) = 0.2|x|$



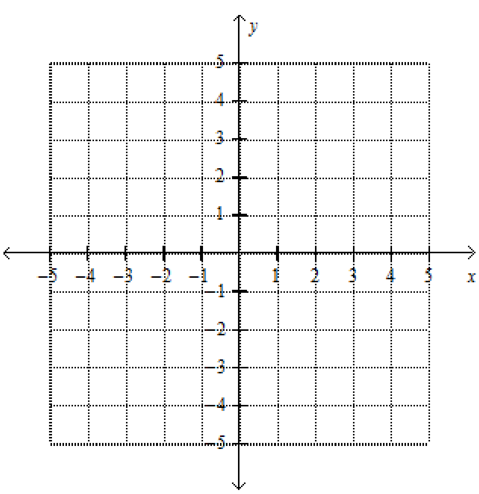
X	Y

X	Y



X	Y

X	Y



X	Y

X	Y

EXAMPLE 5 Describing Combinations of Transformations

Use a graphing calculator to graph $g(x) = -|x + 5| - 3$ and its parent function. Then describe the transformations.