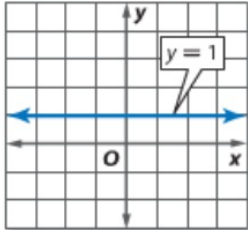
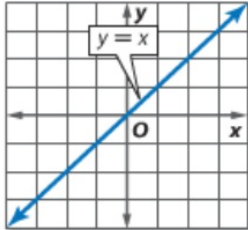
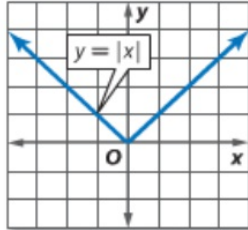
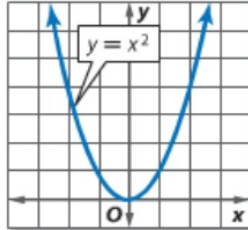
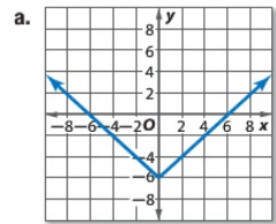


2-7 Parent Functions and Transformation

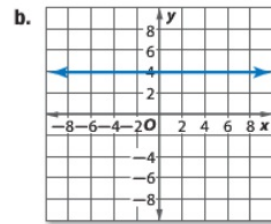
KeyConcept Parent Functions	
<p>Constant Function</p>  <p>The general equation of a constant function is $f(x) = a$, where a is any number. The domain is all real numbers, and the range consists of a single real number a.</p>	<p>Identity Function</p>  <p>The identity function $f(x) = x$ passes through all points with coordinates (a, a). It is the parent function of most linear functions. Its domain and range are all real numbers.</p>
<p>Absolute Value Function</p>  <p>Recall that the parent function of absolute value functions is $f(x) = x$. The domain of $f(x) = x$ is the set of real numbers, and the range is the set of real numbers greater than or equal to 0.</p>	<p>Quadratic Function</p>  <p>The parent function of quadratic functions is $f(x) = x^2$. The domain of $f(x) = x^2$ is the set of real numbers, and the range is the set of real numbers greater than or equal to 0.</p>

Example 1 Identify a Function Given the Graph

Identify the type of function represented by each graph.

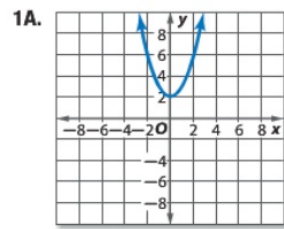


The graph is in the shape of a V.
The graph represents an absolute value function.

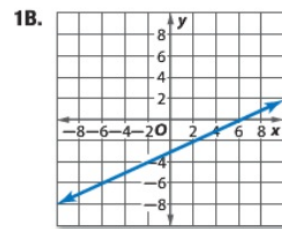


The graph is a horizontal line that crosses the y -axis at 4. The graph represents a constant function.

Guided Practice



quadratic

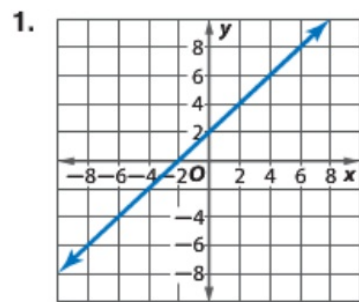


linear

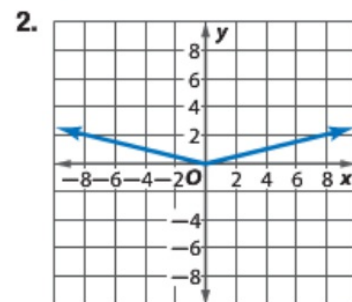
Check Your Understanding

 = Step-by-Step Solutions begin on page R14

Example 1 Identify the type of function represented by each graph.



linear



absolute value

2 Transformations Transformations of a parent graph may appear in a different location, flip over an axis, or appear to have been stretched or compressed. The transformed graph may resemble the parent graph, or it may not.

A **translation** moves a figure up, down, left, or right.

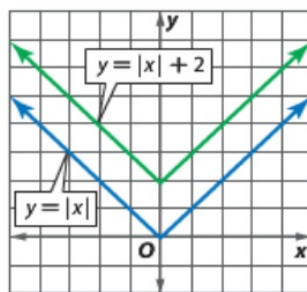
- When a constant k is added to or subtracted from a parent function, the result $f(x) \pm k$ is a translation of the graph up or down.
- When a constant h is added to or subtracted from x before evaluating a parent function, the result, $f(x \pm h)$, is a translation left or right.



Example 2 Describe and Graph Translations

Describe the translation in $y = |x| + 2$. Then graph the function.

The graph of $y = |x| + 2$ is a translation of the graph of $y = |x|$ up 2 units.



Example 2



SENSE-MAKING

Describe the translation in each function. Then graph the function.

3. $y = x^2 - 4$

4. $y = |x + 1|$

3, 4. S

A **reflection** flips a figure over a line called the **line of reflection**.

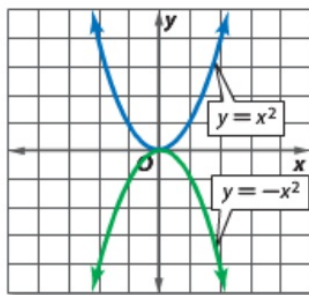
- When a parent function is multiplied by -1 , the result $-f(x)$ is a reflection of the graph in the x -axis.
- When only the variable is multiplied by -1 , the result $f(-x)$ is a reflection of the graph in the y -axis.



Example 3 Describe and Graph Reflections

Describe the reflection in $y = -x^2$. Then graph the function.

The graph of $y = -x^2$ is a reflection of the graph of $y = x^2$ in the x -axis.



Example 3 Describe the reflection in each function. Then graph the function.

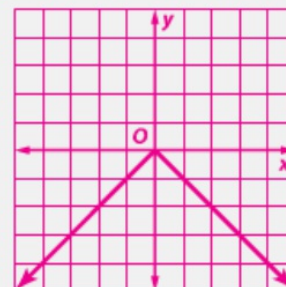
5. $y = -|x|$

6. $y = (-x)^2$

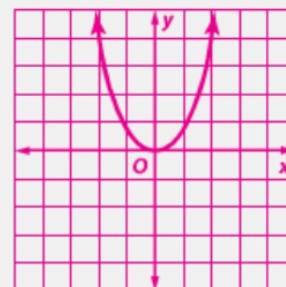
x^2

Additional Answers

5. reflection of the graph of $y = |x|$ across the x -axis



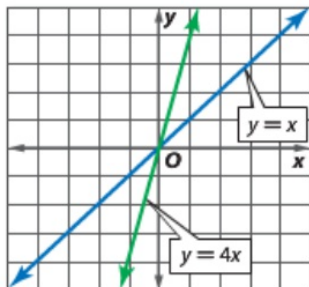
6. reflection of the graph of $y = x^2$ across the y -axis



Example 4 Describe and Graph Dilations

Describe the dilation in $y = 4x$. Then graph the function.

The graph of $y = 4x$ is a dilation of the graph of $y = x$. The slope of the graph of $y = 4x$ is steeper than that of the graph of $y = x$.

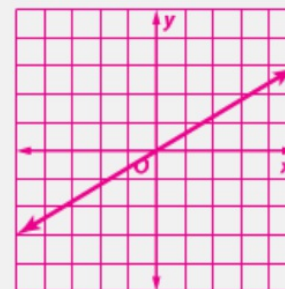


Example 4 Describe the dilation in each function. Then graph the function.

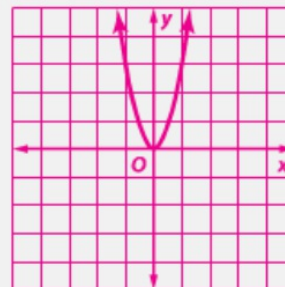
7. $y = \frac{3}{5}x$

8. $y = 3x^2$

7. A vertical compression of the graph of $y = x$; the slope is not as steep as that of $y = x$.

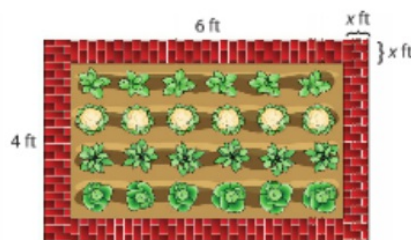


8. The dilation stretches the graph of $y = x^2$ vertically.



Real-World Example 5 Identify Transformations

LANDSCAPING Ethan is going to add a brick walkway around the perimeter of his vegetable garden. The area of the walkway can be represented by the function $f(x) = 4(x + 2.5)^2 - 25$. Describe the transformations in the function. Then graph the function.



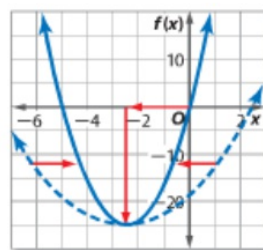
The graph of $f(x) = 4(x + 2.5)^2 - 25$ is a combination of transformations of the parent graph $f(x) = x^2$. Determine how each transformation affects the parent graph.

$$f(x) = 4(x + 2.5)^2 - 25$$

$+ 2.5$ translates $f(x) = x^2$ left 2.5 units.

$- 25$ translates $f(x) = x^2$ down 25 units.

4 stretches $f(x) = x^2$ vertically.

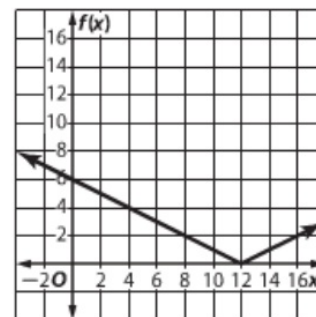


Example 5

9. **FOOD** The manager of a coffee shop is randomly checking coffee drinks prepared by employees to ensure that the correct amount of coffee is in each cup. Each 12-ounce drink should contain half coffee and half steamed milk. The amount of coffee by which each drink varies can be represented by $f(x) = \frac{1}{2}|x - 12|$. Describe the transformations in the function. Then graph the function. **See Chapter 2 Answer Appendix.**

Lesson 2-7

9. The function is a dilation and translation. The graph of $f(x) = \frac{1}{2}|x - 12|$ compresses the graph $f(x) = |x|$ vertically and translates it 12 units to the right.

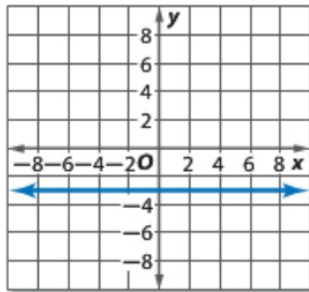


ConceptSummary Transformations of Functions

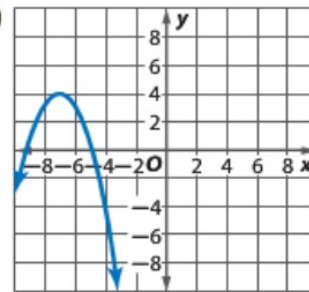
Transformation	Change to Parent Graph
Translation $f(x + h), h > 0$ $f(x - h), h > 0$ $f(x) + k, k > 0$ $f(x) - k, k > 0$	Translates graph h units left. Translates graph h units right. Translates graph k units up. Translates graph k units down.
Reflection $-f(x)$ $f(-x)$	Reflects graph in the x -axis. Reflects graph in the y -axis.
Dilation $a \cdot f(x), a > 1$ $a \cdot f(x), 0 < a < 1$ $f(bx), b > 1$ $f(bx), 0 < b < 1$	Stretches graph vertically. Compresses graph vertically Compresses graph horizontally. Stretches graph horizontally.

Example 1 Identify the type of function represented by each graph.

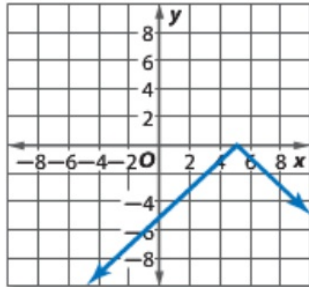
10. constant



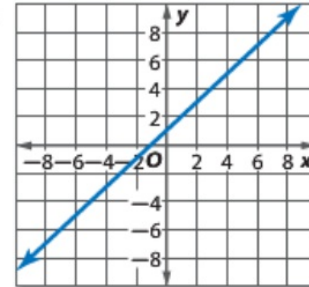
11. quadratic



12. absolute value



13. linear



**Example 2**Describe the translation in each function. Then graph the function. **14–19. See margin.**

14. $y = x^2 + 4$

15. $y = |x| - 3$

16. $y = x - 1$

17. $y = x + 2$

18. $y = (x - 5)^2$

19. $y = |x + 6|$

Example 3Describe the reflection in each function. Then graph the function. **20–25. See Chapter 2 Answer Appendix.**

20. $y = -x$

21. $y = -x^2$

22. $y = (-x)^2$

23. $y = |-x|$

24. $y = -|x|$

25. $y = (-x)$

Example 4Describe the dilation in each function. Then graph the function. **26–31. See Chapter 2 Answer Appendix.**

26. $y = (3x)^2$

27. $y = 6x$

28. $y = 4|x|$

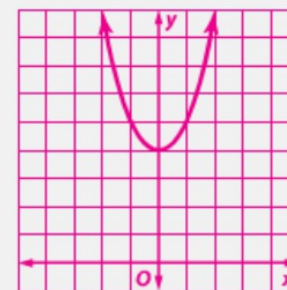
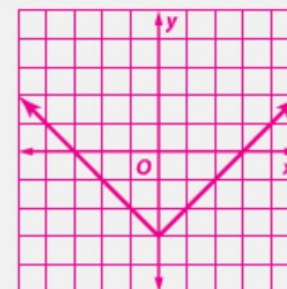
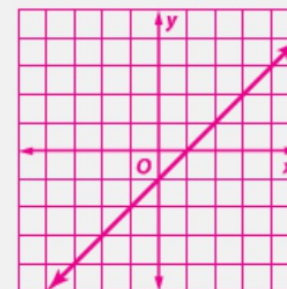
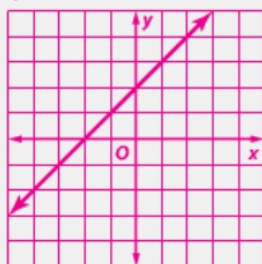
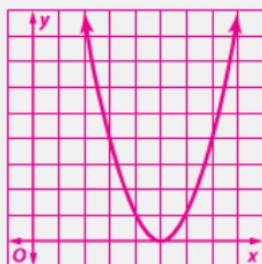
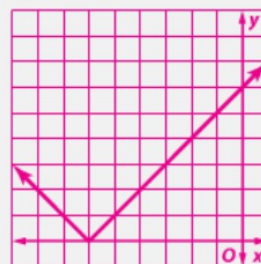
29. $y = |2x|$

30. $y = \frac{2}{3}x$

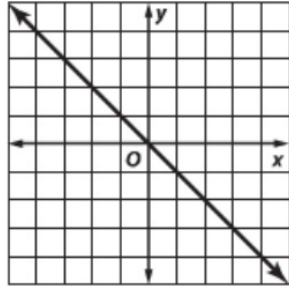
31. $y = \frac{1}{2}x^2$

Example 5

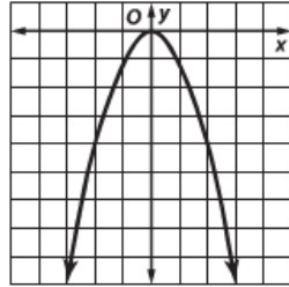
32. CCSS SENSE-MAKING A non-impact workout can burn up to 7.5 Calories per minute. The equation to represent how many Calories a person burns after m minutes of the workout is $C(m) = 7.5m$. Identify the transformation in the function. Then graph the function. **See Chapter 2 Answer Appendix.**

14. translation of the graph of $y = x^2$ up 4 units15. translation of the graph of $y = |x|$ down 3 units16. translation of the graph of $y = x$ down 1 unit or right 1 unit17. translation of the graph of $y = x$ up 2 units or left 2 units18. translation of the graph of $y = x^2$ right 5 units19. translation of the graph of $y = |x|$ left 6 units

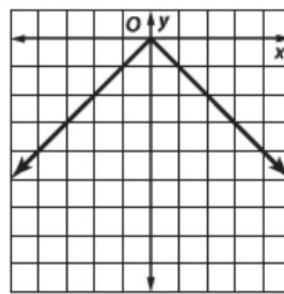
20. reflection of the graph of $y = x$ across the x -axis



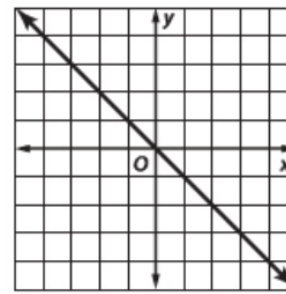
21. reflection of the graph of $y = x^2$ across the x -axis



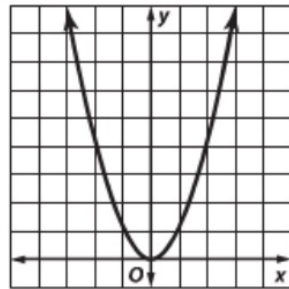
24. reflection of the graph of $y = |x|$ across the x -axis



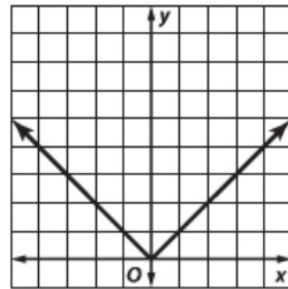
25. reflection of the graph of $y = x$ across the y -axis



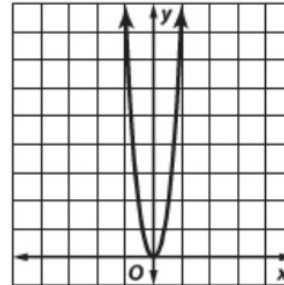
22. reflection of the graph of $y = x^2$ across the y -axis



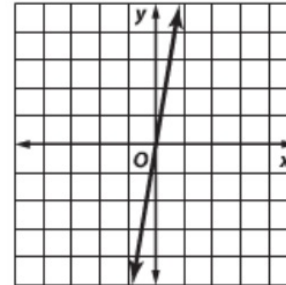
23. reflection of the graph of $y = |x|$ across the y -axis



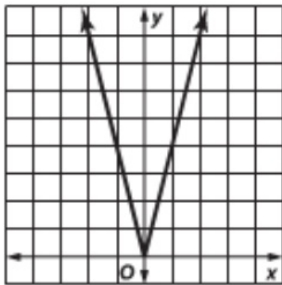
26. horizontal compression of the graph of $y = x^2$



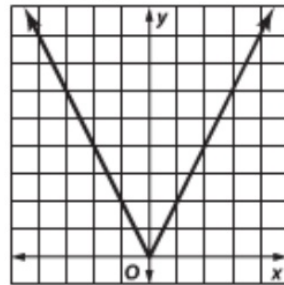
27. vertical expansion of the graph of $y = x$; The slope is steeper than that of $y = x$.



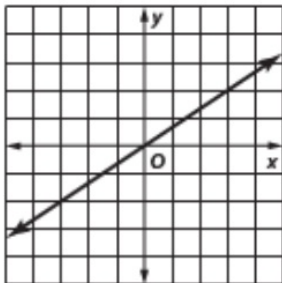
28. The dilation stretches the graph of $y = |x|$ vertically.



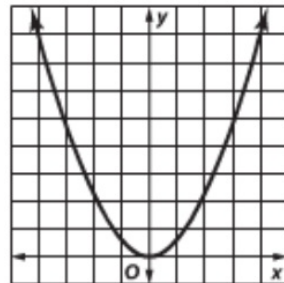
29. The dilation compresses the graph of $y = |x|$ horizontally.



30. The dilation compresses the graph of $y = x$ vertically; the slope is not as steep as that of $y = x$.



31. vertical compression of the graph of $y = x^2$



32. The graph is a dilation of the graph of $y = x$. The dilation stretches the graph vertically.

