5-10 Transforming Linear Functions

Warm Up

Lesson Presentation

Lesson Quiz

5-10 Transforming Linear Functions

Warm Up

Identify slope and *y*-intercept.

1. $y = x + 4$ $m = 1;\ b = 4$

2. $y = -3x$ $m = -3;\ b = 0$

Compare and contrast the graphs of each pair of equations.

3. $y = 2x + 4$ and $y = 2x - 4$

same slope, parallel, and different intercepts

4. $y = 2x + 4$ and $y = -2x + 4$

same y-intercepts; different slopes but same steepness

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Objective

Describe how changing slope and *y*-intercept affect the graph of a linear function.

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Vocabulary

$y=x$
$y=x^2$
$y=x^3$
$y=|x|$
$y=\cos x$

family of functions
parent function
transformation
translation – slide
rotation – turn
reflection – flip

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A **family of functions** is a set of functions whose graphs have basic characteristics in common. For example, all linear functions form a family because all of their graphs are the same basic shape.

A **parent function** is the most basic function in a family. For linear functions, the parent function is $f(x) = x$.

The graphs of all other linear functions are *transformations* of the graph of the parent function, $f(x) = x$. A **transformation** is a change in position or size of a figure.

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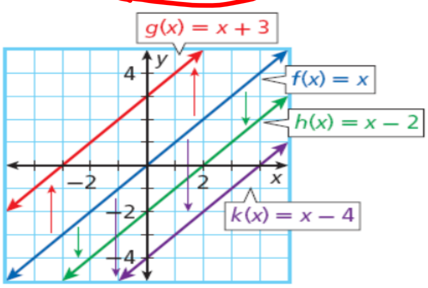
The graphs of $g(x) = x + 3$, $h(x) = x - 2$, and $k(x) = x - 4$, are *vertical translations* of the graph of the parent function, $f(x) = x$. A **translation** is a type of transformation that moves every point the same distance in the same direction. You can think of a translation as a "slide."



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b = change vertically

Vertical Translation of a Linear Function

When the y-intercept b is changed in the function $f(x) = mx + b$, the graph is translated vertically.

- If b increases, the graph is translated up.
- If b decreases, the graph is translated down.

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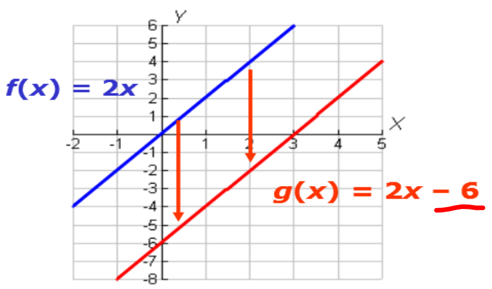
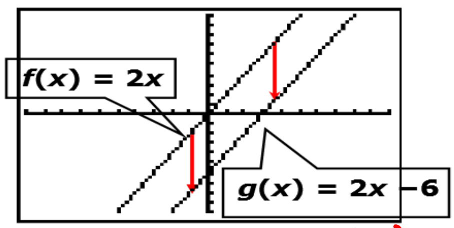
Example 1: Translating Linear Functions

Graph $f(x) = 2x$ and $g(x) = 2x - 6$. Then describe the transformation from the graph of $f(x)$ to the graph of $g(x)$.





Vertical translation -6

The graph of $g(x) = 2x - 6$ is the result of translating the graph of $f(x) = 2x$ 6 units down.

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x $\frac{1}{1000}$

The graphs of $g(x) = 3x$, $h(x) = 5x$, and $k(x) = \frac{1}{2}x$ are *rotations* of the graph $f(x) = x$. A **rotation** is a transformation about a point. You can think of a rotation as a "turn." The y-intercepts are the same, but the slopes are different.

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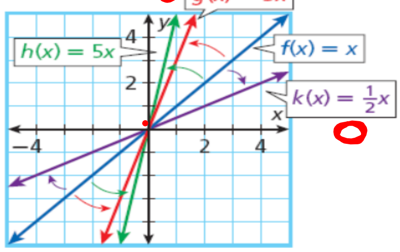

0 0

$-\infty$

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Rotation about the point (0,b)

Rotation of a Linear Function

When the slope m is changed in the function $f(x) = mx + b$ it causes a rotation of the graph about the point $(0, b)$, which changes the line's steepness.

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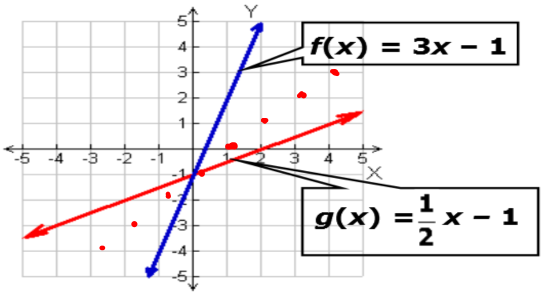
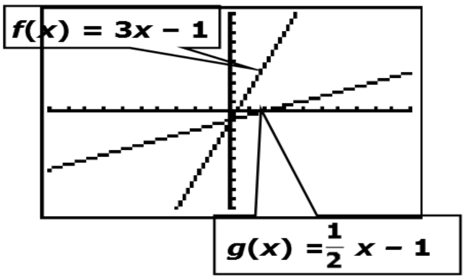
Check It Out! Example 2

Graph $f(x) = 3x - 1$ and $g(x) = \frac{1}{2}x - 1$. Then describe the transformation from the graph of $f(x)$ to the graph of $g(x)$.





The graph of $g(x)$ is the result of rotating the graph of $f(x)$ about (0, −1). The graph of $g(x)$ is less steep than the graph of $f(x)$.

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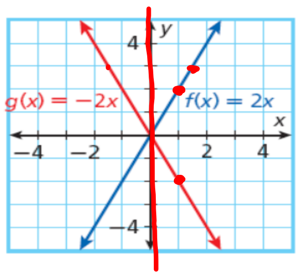
The diagram shows the *reflection* of the graph of $f(x) = 2x$ across the y-axis, producing the graph of $g(x) = -2x$. A **reflection** is a transformation across a line that produces a mirror image. You can think of a reflection as a "flip" over a line.



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Reflection of a Linear Function

When the slope m is multiplied by -1 in $f(x) = mx + b$, the graph is reflected across the y-axis.

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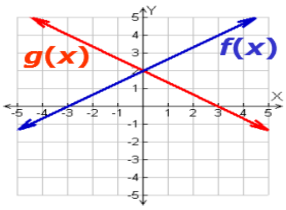
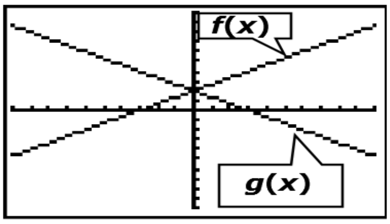
Check It Out! Example 3

Graph $f(x) = \frac{2}{3}x + 2$. Then reflect the graph of $f(x)$ across the y-axis. Write a function $g(x)$ to describe the new graph.

$f(x) = \frac{2}{3}x + 2$



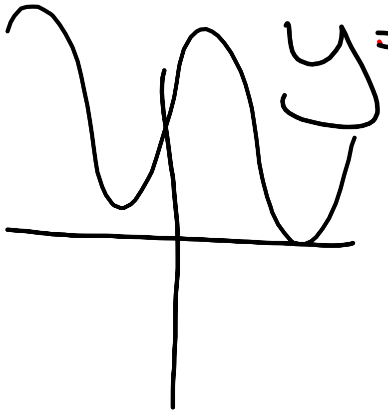


To find $g(x)$, multiply the value of m by -1.

In $f(x) = \frac{2}{3}x + 2$, $m = \frac{2}{3}$.

$\frac{2}{3}(-1) = -\frac{2}{3}$ *This is the value of m for g(x).*

$g(x) = -\frac{2}{3}x + 2$

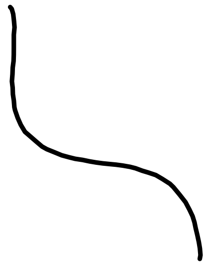


$y = mx + b$

Reflect

Rotation

Vertical Change



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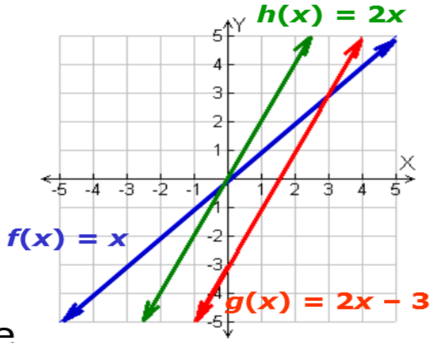
Example 4: Multiple Transformations of Linear Functions

Graph $f(x) = x$ and $g(x) = 2x - 3$. Then describe the transformations from the graph of $f(x)$ to the graph of $g(x)$.

Find transformations of $f(x) = x$ that will result in $g(x) = 2x - 3$:

- Multiply $f(x)$ by 2 to get $h(x) = 2x$. This rotates the graph about (0, 0) and makes it parallel to $g(x)$.
- Then subtract 3 from $h(x)$ to get $g(x) = 2x - 3$. This translates the graph 3 units down.



The transformations are a rotation and a translation.

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Example 5: *Business Application*

A florist charges $25 for a vase plus $4.50 for each flower. The total charge for the vase and flowers is given by the function $f(x) = 4.50x + 25$. How will the graph change if the vase's cost is raised to $35? if the charge per flower is lowered to $3.00?

$f(x) = 4.5x + 25$ $g(x) = 3x + 35$

Rotated down from 4.5 to 3

Translation up 10 units

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Example 5 Continued

A florist charges $25 for a vase plus $4.50 for each flower. The total charge for the vase and flowers is given by the function $f(x) = 4.50x + 25$. How will the graph change if the vase's cost is raised to $35? If the charge per flower is lowered to $3.00?

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5-10 Transforming Linear Functions

Lesson Quiz: Part I

Describe the transformation from the graph of *f(x)* to the graph of *g(x)*.

1. $f(x) = 4x$, $g(x) = x$ Rotation the steepness down from 4 to 1
   rotated about (0, 0) (less steep)
2. $f(x) = x - 1$, $g(x) = x + 6$
   translated 7 units up
3. $f(x) = \frac{1}{5}x$, $g(x) = 2x$
   rotated about (0, 0) (steeper)
4. $f(x) = 5x$, $g(x) = -5x$
   reflected across the y-axis

5-10 Transforming Linear Functions

Lesson Quiz: Part II

5. $f(x) = x$, $g(x) = x - 4$
   translated 4 units down
6. $f(x) = -3x$, $g(x) = -x + 1$
   rotated about (0, 0) (less steep),
   translated 1 unit up

$g(x) = 12x + 75$

(0,6)
(0,50)

7. A cashier gets a \$50 bonus for working on a holiday plus \$9/h. The total holiday salary is given by the function $f(x) = 9x + 50$. How will the graph change if the bonus is raised to \$75? if the hourly rate is raised to \$12/h?
   translate 25 units up; rotated about (0, 50) (steeper)

$f(x) = 2x - 3$

$\times 3 \quad +5$

$-6x+2$

$g(x) = -6x+2$

3 X as steep

5 units higher

Reflected across y-axis

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$y = mx + b$

$\times 2 \quad \pm 12$

$y = (-)2x - 6$

$2x - 6$

$y = 3x - 7$

$-3x - 7$

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$y = |x - 2|$

$y = |x - (-4)|$

$|x + 4|$

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