LESSON PRACTICE

Packet: 17, 18, 19

17 Translating Functions Name Key

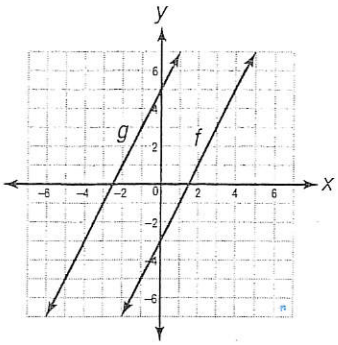
1. Which equation represents the translation of $f(x) = 5x + 3$ shifted down 4 units?

Ⓐ $g(x) = 5x - 4$
Ⓑ $g(x) = 5x - 1$
Ⓒ $g(x) = 5x + 4$
Ⓓ $g(x) = 5x + 7$

2. Which equation represents the translation of $f(x) = \left(\frac{2}{3}\right)^{x-1} + 1$ shifted left 5 units?

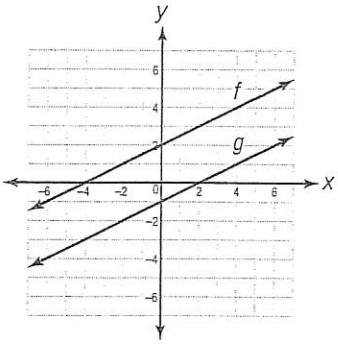
Ⓐ $g(x) = \left(\frac{2}{3}\right)^{x-6} + 1$
Ⓑ $g(x) = \left(\frac{2}{3}\right)^{x-5} + 1$
Ⓒ $g(x) = \left(\frac{2}{3}\right)^{x+4} + 1$
Ⓓ $g(x) = \left(\frac{2}{3}\right)^{x+5} + 1$

3. The graph of g is a translation of the graph of f. Which equation could represent g?



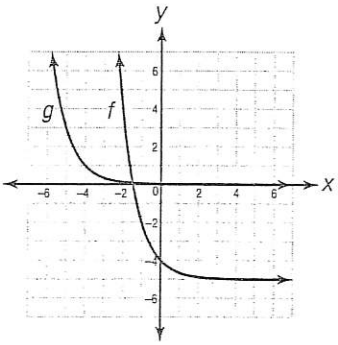
Ⓐ $g(x) = f(x) + 4$
Ⓑ $g(x) = f(x) - 4$
Ⓒ $g(x) = f(x + 4)$
Ⓓ $g(x) = f(x - 4)$

4. The graph of g is a translation of the graph of f. Which equation could represent g?



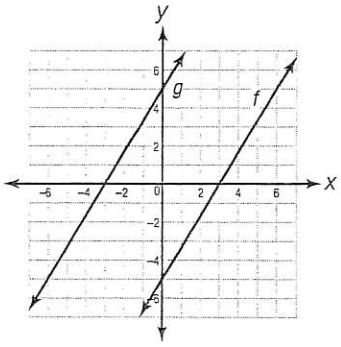
Ⓐ $g(x) = f(x) + 3$
Ⓑ $g(x) = f(x) - 3$
Ⓒ $g(x) = f(x + 3)$
Ⓓ $g(x) = f(x - 3)$

5. The graph of g is a translation of the graph of f. Which equation could represent g?



Ⓐ $g(x) = f(x - 4) - 5$
Ⓑ $g(x) = f(x + 4) - 5$
Ⓒ $g(x) = f(x - 4) + 5$
Ⓓ $g(x) = f(x + 4) + 5$

6 The graph of g is a translation of the graph of f. Which equations could represent g? Select all that apply.



- [x] **A.** $g(x) = f(x) + 10$
- [ ] **B.** $g(x) = f(x) - 10$
- [x] **C.** $g(x) = f(x + 6)$
- [ ] **D.** $g(x) = f(x - 6)$
- [x] **E.** $g(x) = f(x + 3) + 5$
- [ ] **F.** $g(x) = f(x - 3) - 5$

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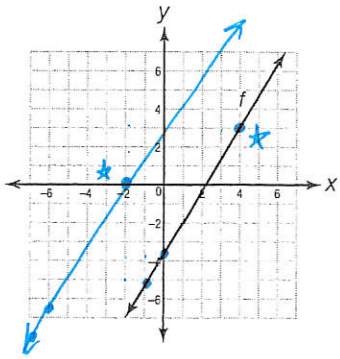
7 The graph of function g is a translation of the graph of $f(x) = \frac{5}{3}(x - 4) + 3$ shifted left 6 units and down 3 units.

← 6 ↓ 3

Part A

Graph g.



Part B

Write an equation for g.

$g(x) =$ $\frac{5}{3}x + \frac{10}{3}$

$\frac{5}{3}(x - 4 + 6) + 3 - 3$

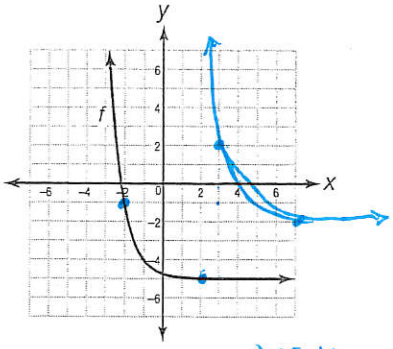
← 6 ↓ 3

$\frac{5}{3}(x+2)+0 \rightarrow \frac{5}{3}x + \frac{10}{3}$

8 The graph of function g is a translation of the graph of $f(x) = \left(\frac{1}{4}\right)^{x+1} - 5$ shifted right 5 units and up 3 units.

Part A

Graph g.



Part B $g(x) = \left(\frac{1}{4}\right)^{x-4} - 2$

Write an equation for g.

$g(x) =$

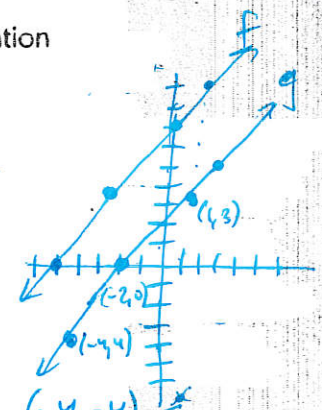
$\left(\frac{1}{4}\right)^{x+1-5} - 5 + 3$

$\left(\frac{1}{4}\right)^{x-4} - 2$

9 The points (−5, 0), (−3, 4), (0, 7), and (1, 9) are on the graph of f. The graph of g is the translation of the graph of f shifted down 4 units and right 1 unit. Which points are on the graph of g?

Point	On the graph of g	Not on the graph of g
(−9, 1)	○	●
(−4, −4)	●	○
(−3, 8)	○	●
(−2, 0)	●	○
(1, 3)	●	○
(2, 5)	●	○

x	y
−5	0
−3	4
0	7
1	9



(−4, −4) ✓
(−2, 0) ✓
(+1, 3) ✓
(2, 5) ✓

10 Let $f(x) = 6^x + 2$. Write an equation of g for each translation of f described in the table.

WORK

6^x+2+5
6^x+2-3
$6^{x+2}+2$
$6^{x-4}+2$
$6^{x+3}+2+8$
$6^{x-7}+2-4$

Translation of f	Equation of g
shift up 5 units	6^x+7
shift down 3 units	6^x-1
shift left 2 units	$6^{x+2}+2$
shift right 4 units	$6^{x-4}+2$
shift up 8 units and left 3 units	$6^{x+3}+10$
shift down 4 units and right 7 units	$6^{x-7}-2$

11 Let (3, −4) be a point on the graph of f and let $g(x) = f(x - 3) + 5$. What is a point on the graph of g? Explain how you found your answer.

$g(x) = f(x-3) + 5$

right 3 — add 3 to x
up 5 — add 5 to y

$3+3=6$
$-4+5=1$

(6, 1) is on graph g because the graph is shifted up 5 units + right 3 units

12 Let $f(x) = 4^x$. Explain why the graphs of the functions $g(x) = \frac{1}{4} \cdot 4^x$ and $g(x) = 16 \cdot 4^x$ are translations of the graph of f.

$g(x) = \frac{1}{4} \cdot 4^x = 4^{-1} \cdot 4^x = 4^{x-1}$ so the graph is a horizontal translation shifted right 1 unit

$g(x) = 16 \cdot 4^x = 4^2 \cdot 4^x = 4^{x+2}$ so the graph is a horizontal translation shifted left 2 units

13 Let $f(x) = \frac{1}{2}x$.

Part A

How does the graph of f compare to the graph of $g(x) = f(x - 4) + 2$?

$\frac{1}{2}(x-4)+2$

$\frac{1}{2}x - 2 + 2$

$\frac{1}{2}x$

They are the same.

Part B

What must be true for the graph of $g(x) = f(x + a) + b$ to be the same as the graph of f? Explain how you know.

If $-\frac{b}{a} = \frac{1}{2}$ then the graph of g is the same as the graph of f.

If (x, y) in on f then $(x-a, y+b)$ is on g.

$\therefore \frac{(y+b) - y}{(x-a) - x} = -\frac{b}{a} = \frac{1}{2}$ (slopes)

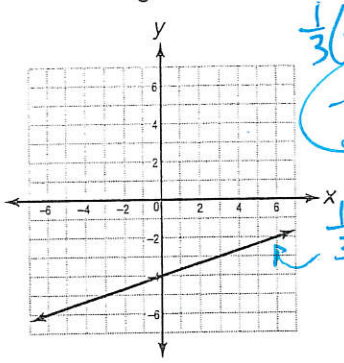
LESSON PRACTICE

(18) Reflecting Functions

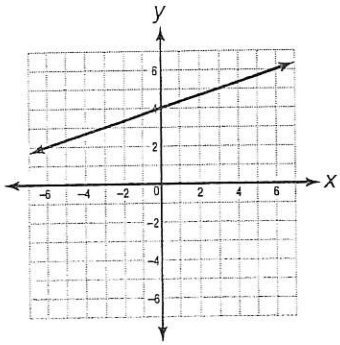
1 Which graph shows the reflection of the graph of $f(x) = \frac{1}{3}x - 4$ across the y-axis?

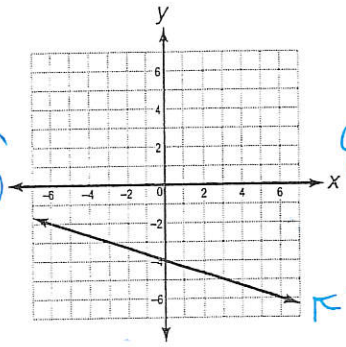
$\frac{1}{3}(-x) - 4$

$-\frac{1}{3}x - 4$

Ⓐ 

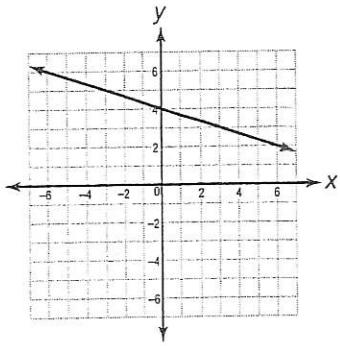
$\frac{1}{3}x - 4$

Ⓑ 

Ⓒ 

graphed w/ calc

$-\frac{1}{3}x - 4$

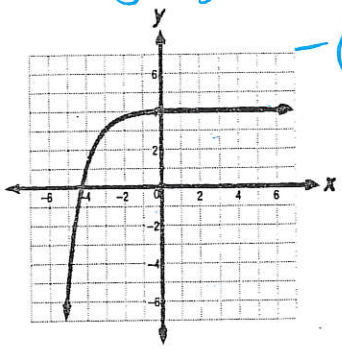
Ⓓ 

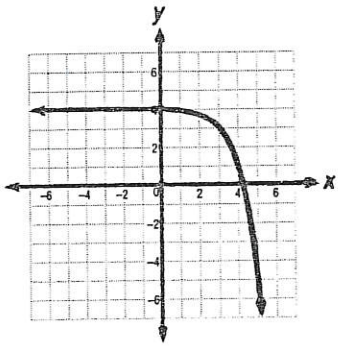
2 Which graph shows the reflection of the graph of $f(x) = -\left(\frac{1}{3}\right)^{x+3} + 4$ across the x-axis? → y sign changes

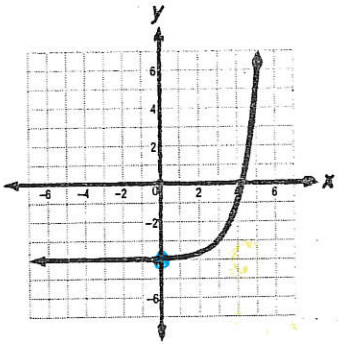
$-\left(-\left(\frac{1}{3}\right)^{x+3} + 4\right)$

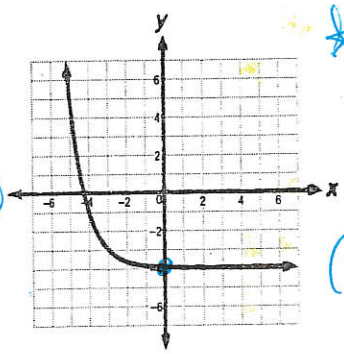
$\left(\frac{1}{3}\right)^{x+3} - 4$

↑ eliminates A + B

Ⓐ 

Ⓑ 

Ⓒ 

Ⓓ 

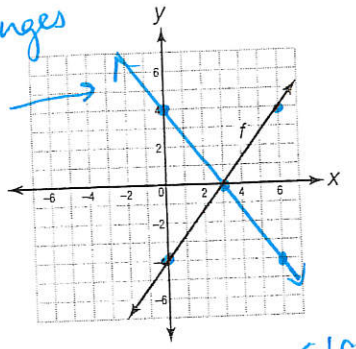
*graphed w/ calc

$\left(\frac{1}{3}\right)^{x+3} - 4$

3 The linear function f is graphed on the coordinate plane. Let the graph of g be the reflection of the graph of f across the x-axis. Which equation could represent g?

y changes

$-\frac{4}{3}x+4$



x	f(x)	g(x)
0	-4	4
3	0	0
6	4	-4

Ⓐ $g(x) = -\frac{4}{3}x + 4$

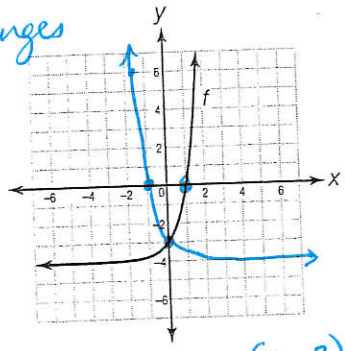
Ⓑ $g(x) = -\frac{4}{3}x - 4$

Ⓒ $g(x) = \frac{4}{3}x + 4$

Ⓓ $g(x) = \frac{4}{3}x - 4$

4 The exponential function f is graphed on the coordinate plane. Let the graph of g be the reflection of the graph of f across the y-axis. Which equation could represent g?

x changes



Ⓐ $g(x) = 4^{-x} - 4$

Ⓑ $g(x) = 4^{-x} \cancel{+4}$

Ⓒ $g(x) = -4^{-x} - 4$

Ⓓ $g(x) = -4^{-x} \cancel{+4}$

$(0,-3) \to (0,-3)$
$(1,0) \to (-1,0)$

* graph A + C to see which graph matches the picture

5 The points $\left(-3, -2\frac{1}{2}\right)$, $(-1, -1)$, $(0, 1)$, and $(2, 13)$ are on the graph of f. Which points are on the graph of the reflection of the graph f across the x-axis and which points are on the graph of the reflection of the graph f across the y-axis?

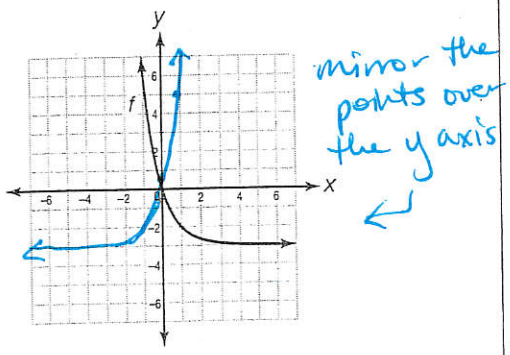
Point	Across the x-axis (-y)	Across the y-axis (-x)	Neither
$\left(-3, 2\frac{1}{2}\right)$	●	○	○
$(-2, -13)$	○	○	●
$(-2, 13)$	○	●	○
$(0, -1)$	●	○	○
$(0, 1)$	○	●	○
$(1, -1)$	○	●	○
$(1, 1)$	○	○	●
$(2, -13)$	●	○	○

both signs changed

6 The graph of function g is a reflection of the graph of $f(x) = \left(\frac{1}{3}\right)^{x-1} - 3$ across the y-axis. → x changes

Part A $f(-x) = \left(\frac{1}{3}\right)^{-x-1} - 3$

Graph g.



Part B

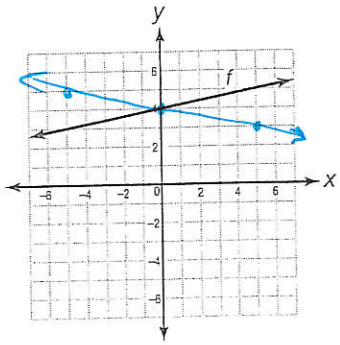
Write an equation for g.

$g(x) =$ $\left(\frac{1}{3}\right)^{(-x-1)} - 3$

7 The graph of function g is a reflection of the graph of $f(x) = \frac{1}{5}x + 4$ across the y-axis. → $-x$

Part A $\frac{1}{5}(-x) + 4$

Graph g. $-\frac{1}{5}x + 4$



Part B

Write an equation for g.

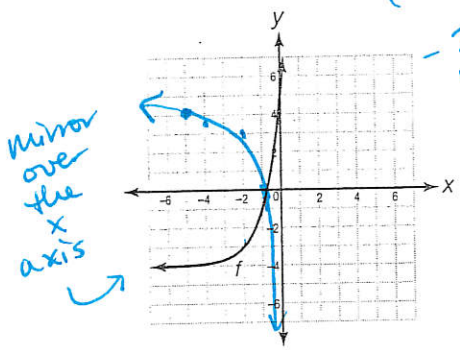
$g(x) =$ $-\frac{1}{5}x + 4$

8 The graph of function g is a reflection of the graph of $f(x) = 3^{x+2} - 4$ across the x-axis. → y values change

Part A

Graph g. $-(3^{x+2} - 4)$

$-3^{x+2} + 4$



Part B

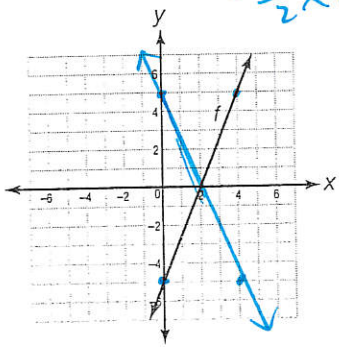
Write an equation for g.

$g(x) =$ $-3^{x+2} + 4$

9 The graph of function g is a reflection of the graph of $f(x) = \frac{5}{2}x - 5$ across the x-axis. → $-y$ or $-f(x)$

Part A $-\left(\frac{5}{2}x - 5\right)$

Graph g. $-\frac{5}{2}x + 5$



Part B

Write an equation for g.

$g(x) =$ $-\frac{5}{2}x + 5$

10 Let $f(x) = \left(\frac{1}{4}\right)^x$. Explain why the graph of the function $g(x) = 4^x$ is the reflection of the graph of f across the y-axis.

$\left(\frac{1}{4}\right)^x = (4^{-1})^x = 4^{-x} = g(-x)$

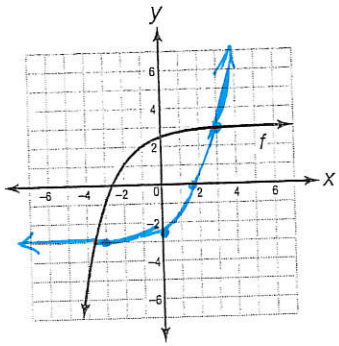
OR $4^x = (4^{-1})^{-x} = \left(\frac{1}{4}\right)^{-x} = f(-x)$

So the graphs of $f(x)$ + $g(x)$ are reflections across the y-axis.

11 The graph of function g is a reflection of the graph of $f(x) = -\left(\frac{1}{2}\right)^{x+1} + 3$ across the x-axis and across the y-axis.

Part A

Graph g.



y-axis

$-\left(\frac{1}{2}\right)^{(-x)+1} + 3$

$-\left(\frac{1}{2}\right)^{-x+1} + 3$

now... x-axis

$-\left(-\left(\frac{1}{2}\right)^{-x+1} + 3\right)$

$\left(\frac{1}{2}\right)^{-x+1} - 3$

Part B

Write an equation for g.

$g(x) = \left(\frac{1}{2}\right)^{-x+1} - 3$

Part C

If a point (a, b) is on the graph of f, what point is on the graph of g? Explain how you found your answer.

The point $(-a, -b)$ is on the graph of g.
$-a$ reflects (a,b) over the x-axis and
$-b$ reflects (a,b) over the y-axis.

3 LESSON PRACTICE

(19) Stretching / Shrinking Functions

1 Which equation represents the vertical shrink of $f(x) = 4x + 1$ by a factor of $\frac{1}{2}$?

Ⓐ $g(x) = 2x + 1$

Ⓑ $g(x) = 2x + \frac{1}{2}$

Ⓒ $g(x) = 4x + 2$

Ⓓ $g(x) = 4x + 1$

$\frac{1}{2}(4x+1)$

$2x+\frac{1}{2}$

2 Which equation represents the vertical stretch of $f(x) = 3x + 6$ by a factor of 3?

Ⓐ $g(x) = 9x + 6$

Ⓑ $g(x) = 9x + 18$

Ⓒ $g(x) = x + 2$

Ⓓ $g(x) = x + 6$

$3(3x+6)$

$9x+18$

3 Which equation represents the vertical stretch of $f(x) = 3^x + 2$ by a factor of 2?

Ⓐ $g(x) = 3^{\frac{x}{2}} + 2$

Ⓑ $g(x) = 3^{2x} + 2$

Ⓒ $g(x) = 2 \cdot 3^x + 4$

Ⓓ $g(x) = \frac{1}{2} \cdot 3^x + 1$

$2(3^x+2)$

$2\cdot 3^x+4$

4 Which equation represents the vertical shrink of $f(x) = \left(\frac{1}{3}\right)^x - 4$ by a factor of $\frac{1}{4}$?

Ⓐ $g(x) = \frac{1}{4} \cdot \left(\frac{1}{3}\right)^x - 1$

Ⓑ $g(x) = 4 \cdot \left(\frac{1}{3}\right)^x - 16$

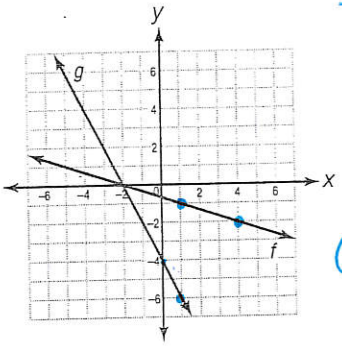
Ⓒ $g(x) = \left(\frac{1}{3}\right)^{\frac{x}{4}} - 4$

Ⓓ $g(x) = \left(\frac{1}{3}\right)^{4x} - 4$

$\frac{1}{4}\left(\left(\frac{1}{3}\right)^x-4\right)$

$\frac{1}{4}\cdot\left(\frac{1}{3}\right)^x-1$

5 The graph of g is a shrink or stretch of the graph of f. Which equation could represent g?



$-\frac{1}{3} \to -2$

$*6$

$(1,-1) \to (1,-6)$

$*6$

? → Ⓐ $g(x) = 6\,f(x)$

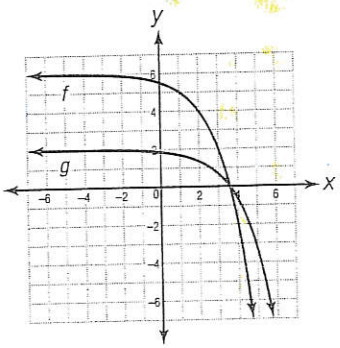
Ⓑ $g(x) = \frac{1}{6}\,f(x)$

Ⓒ $g(x) = f(6x)$

Ⓓ $g(x) = f\left(\frac{1}{6}x\right)$

stretch

6 The graph of g is a shrink or stretch of the graph of f. Which equation could represent g?



Ⓐ $g(x) = 3\,f(x)$

Ⓑ $g(x) = \frac{1}{3}\,f(x)$

Ⓒ $g(x) = f(3x)$

Ⓓ $g(x) = f\left(\frac{1}{3}x\right)$

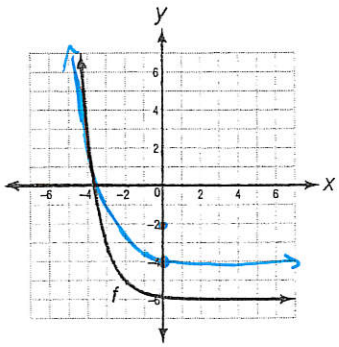
7 The graph of function g is a vertical shrink of the graph of $f(x) = \left(\frac{1}{3}\right)^{x+2} - 6$ by a factor of $\frac{2}{3}$.

$\frac{2}{3}\left(\left(\frac{1}{3}\right)^{x+2} - 6\right)$

Part A

Graph g.

$\frac{2}{3} \cdot \left(\frac{1}{3}\right)^{x+2} - 4$



Part B

Write an equation for g.

$g(x) =$ $\frac{2}{3} \cdot \left(\frac{1}{3}\right)^{x+2} - 4$

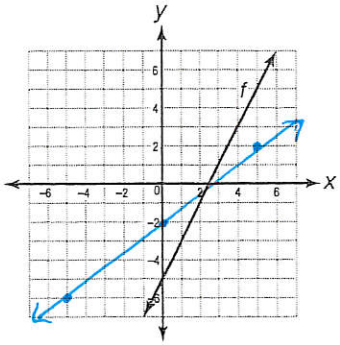
8 The graph of function g is a vertical shrink of the graph of $f(x) = 2x - 5$ by a factor of $\frac{2}{5}$.

$\frac{2}{5}(2x-5)$

Part A

$\frac{4}{5}x - 2$

Graph g.



Part B

Write an equation for g.

$g(x) =$ $\frac{4}{5}x - 2$

9 The points $(-6, 2)$, $(-3, 4)$, $(0, 6)$, $(3, 4)$, and $(9, 0)$ are on the graph of f. The graph of g is the vertical shrink of the graph of f by a factor of $\frac{1}{2}$. The graph of h is the vertical stretch of the graph of f by a factor of 2. Identify which points are on the graph of g or h.

$g(x) = \frac{1}{2}f(x)$

$h(x) = 2f(x)$

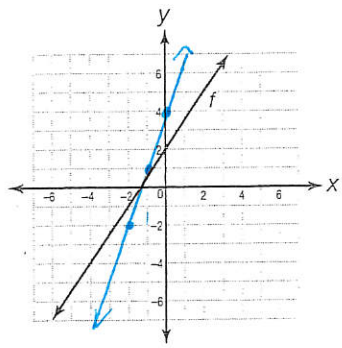
Point	On the graph of g	On the graph of h	Neither
$(-12, 2)$ $(-6, 2)$	○	○	●
$(-6, 2) \rightarrow (-6, 4)$	○	●	○
$(-3, 4) \rightarrow (-3, 2)$	●	○	○
$(0, 6) \rightarrow (0, 6)$	○	○	●
$(3, 4) \rightarrow (3, 2)$	●	○	○
$(3, 4) \rightarrow (3, 8)$	○	●	○
$(3, 4) \rightarrow (6, 4)$	○	○	●
$(9, 0) \rightarrow (9, 0)$	●	●	○

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

$2\left(\frac{3}{2}x+2\right)$

Part A

Graph $g(x) = 2\,f(x)$. $g(x) = 3x+4$

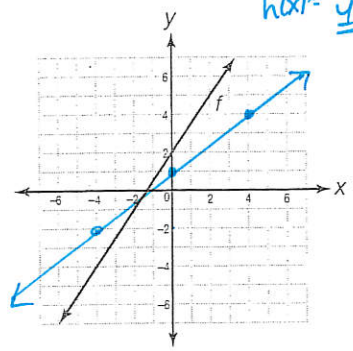


Part B

Graph $h(x) = \frac{1}{2}f(x)$.

$\frac{1}{2}\left(\frac{3}{2}x+2\right)$

$h(x) = \frac{3}{4}x+1$



Part C

How does the slope of the graph of g compare to the slope of the graph of h?

m of $g = 3$
m of $h = \frac{3}{4}$

The slope of g is 4 times the slope of h.

Part D

In general, if f is a linear function, how would the slope of the graph of $g(x) = k\,f(x)$ compare to the slope of the graph of $h(x) = \frac{1}{k}f(x)$? If the slope of f is m, what are the slopes of g and h? Explain how you got your answers.

$g(x) = k\,f(x)$
$h(x) = \frac{1}{k}f(x)$

$\frac{1}{k} \cdot \square = k$

k^2

The slope of g is k^2 times the slope of h.