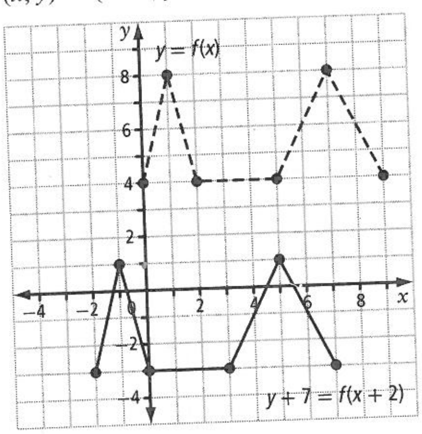
Answers

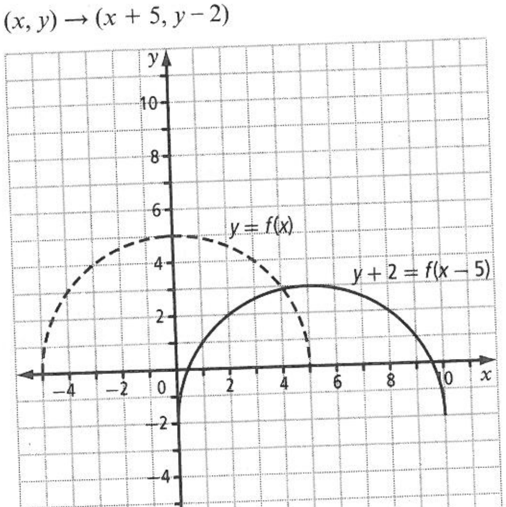
Chapter 1

1.1 Horizontal and Vertical Translations, pages 1–8

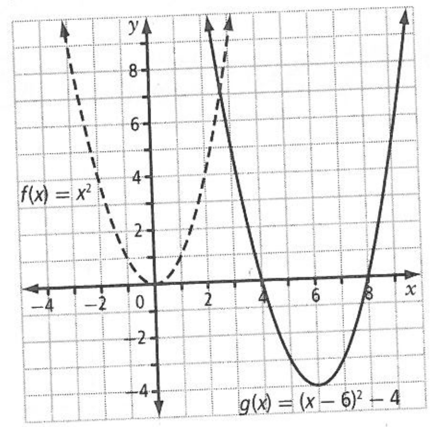
1. a) $h = 10, k = 0$ b) $h = -2, k = 3$
   c) $h = 17, k = 13$ d) $h = -1, k = -7$
   e) $h = 0, k = 4$
2. a) $y + 5 = (x - 2)^2$ b) $y + 5 = |x - 2|$
   c) $y + 5 = \frac{1}{x - 2}, x \neq 2$
3. a) $(x, y) \rightarrow (x + 25, y)$; horizontal translation 25 units to the right
   b) $(x, y) \rightarrow (x, y - 50)$; vertical translation 50 units down
   c) $(x, y) \rightarrow (x - 20, y + 10)$; horizontal translation 20 units to the left and vertical translation 10 units up
4. a) $(x, y) \rightarrow (x - 2, y - 7)$



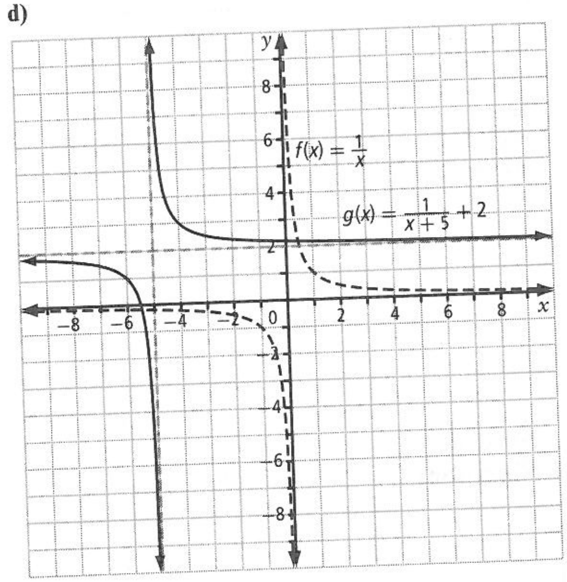
   b) $(x, y) \rightarrow (x + 5, y - 2)$



5. a) $h = 6, k = -4$ b) $(x, y) \rightarrow (x + 6, y - 4)$
   c) $y = (x - 6)^2 - 4$
   d)



   e) (0, 0), (6, −4); vertex has coordinates (h, k)
   f) domain of each function: $\{x \mid x \in R\}$; range of $f(x)$: $\{y \mid y \geq 0, y \in R\}$, range of $g(x)$: $\{y \mid y \geq -4, y \in R\}$; in general, the range is $\{y \mid y \geq k, y \in R\}$
6. a) $h = -5, k = 2$ b) $(x, y) \rightarrow (x - 5, y + 2)$
   c) $y = \frac{1}{x + 5} + 2$
   d)



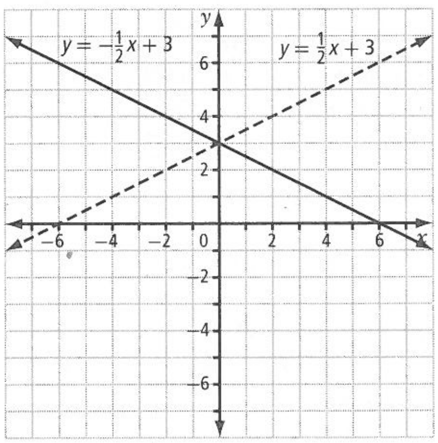
   e) For $f(x)$: domain $\{x \mid x \neq 0, x \in R\}$, range $\{y \mid y \neq 0, y \in R\}$, asymptotes $y = 0, x = 0$; For $g(x)$: domain $\{x \mid x \neq -5, x \in R\}$, range $\{y \mid y \neq 2, y \in R\}$, asymptotes $y = 2, x = -5$; restriction on the domain of $g(x)$ is $x \neq h$, restriction on the range of $g(x)$ is $y \neq k$, asymptotes are at $x = h$ and $y = k$

7.

Function	Horizontal Translation		Vertical Translation	
	to the right 1 unit	to the left 3 units	up 2 units	down 4 units
Quadratic $y = x^2$	$y = (x - 1)^2$ $(x, y) \rightarrow (x + 1, y)$ vertex at (1, 0)	$y = (x + 3)^2$ $(x, y) \rightarrow (x - 3, y)$ vertex at (–3, 0)	$y - 2 = x^2$ $(x, y) \rightarrow (x, y + 2)$ vertex at (0, 2)	$y + 4 = x^2$ $(x, y) \rightarrow (x, y - 4)$ vertex at (0, –4)
Absolute value $y = \|x\|$	$y = \|x - 1\|$ $(x, y) \rightarrow (x + 1, y)$ vertex at (1, 0)	$y = \|x + 3\|$ $(x, y) \rightarrow (x - 3, y)$ vertex at (–3, 0)	$y - 2 = \|x\|$ $(x, y) \rightarrow (x, y + 2)$ vertex at (0, 2)	$y + 4 = \|x\|$ $(x, y) \rightarrow (x, y - 4)$ vertex at (0, –4)
Reciprocal $y = \frac{1}{x}$	$y = \frac{1}{x - 1}$ $(x, y) \rightarrow (x + 1, y)$ vertical asymptote; $x = 1$; horizontal asymptote: $y = 0$	$y = \frac{1}{x + 3}$ $(x, y) \rightarrow (x - 3, y)$ vertical asymptote; $x = -3$; horizontal asymptote: $y = 0$	$y - 2 = \frac{1}{x}$ $(x, y) \rightarrow (x, y + 2)$ vertical asymptote; $x = 0$; horizontal asymptote: $y = 2$	$y + 4 = \frac{1}{x}$ $(x, y) \rightarrow (x, y - 4)$ vertical asymptote; $x = 0$; horizontal asymptote: $y = -4$
Any function $y = f(x)$	$y = f(x - 1)$ $(x, y) \rightarrow (x + 1, y)$	$y = f(x + 3)$ $(x, y) \rightarrow (x - 3, y)$	$y - 2 = f(x)$ $(x, y) \rightarrow (x, y + 2)$	$y + 4 = f(x)$ $(x, y) \rightarrow (x, y - 4)$

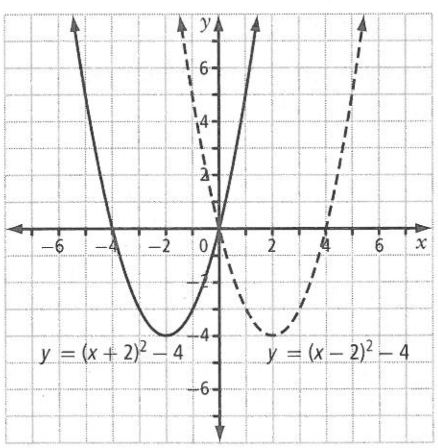
1.2 Reflections and Stretches, pages 9–17

1. a)



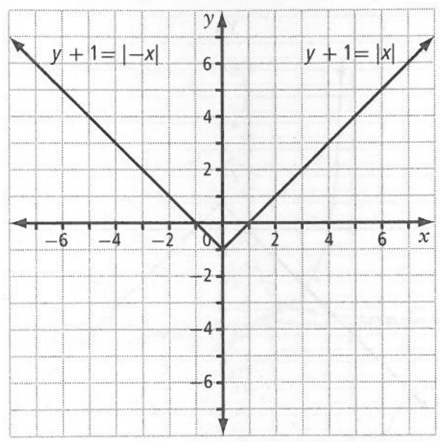
$y = -\frac{1}{2}x + 3$; same y-intercept, different x-intercepts, opposite slopes, same domain and range

b)



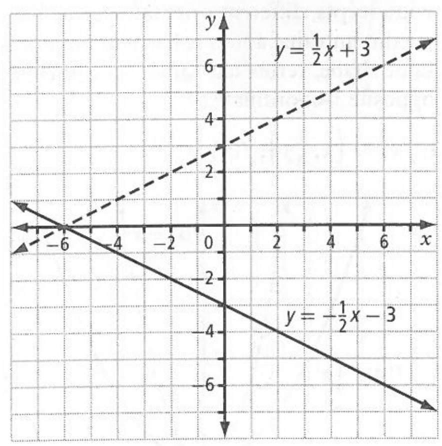
$y + 4 = (x + 2)^2$; same y-intercept, different x-intercepts, same domain and range, same shape, same orientation, vertex has opposite x-coordinate (h) but same y-coordinate (k)

c)

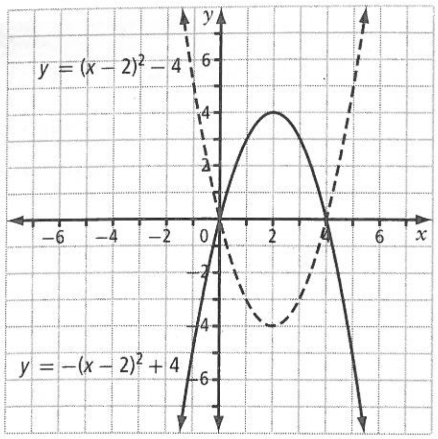


$y + 1 = |-x|$; reflection maps to the original graph

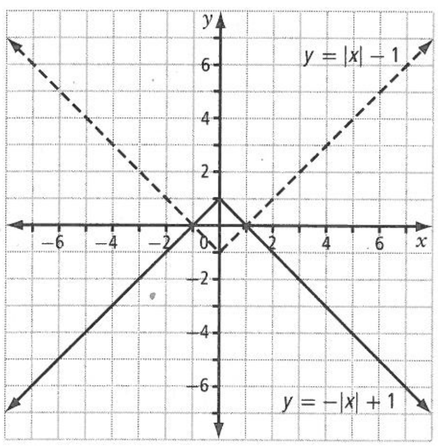
2. a)



$y = -\frac{1}{2}x - 3$; same x-intercept, different y-intercepts, opposite slopes, same domain and range

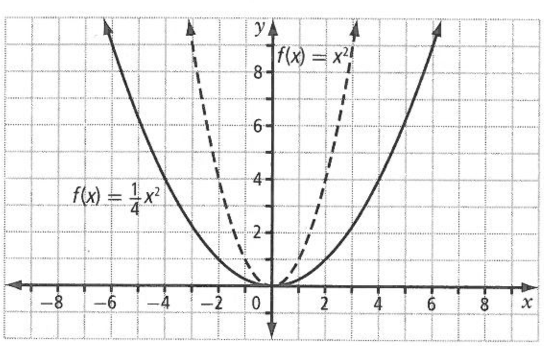
b) 

$y - 4 = -(x - 2)^2$; same y-intercept, same x-intercepts (zeros), different orientation, one has a maximum value and one has a minimum value, same shape, vertex has same x-coordinate (h) and opposite y-coordinate (k)

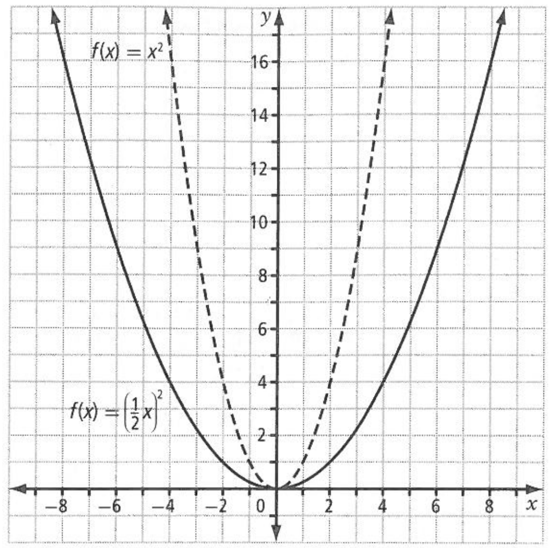
c) 

$y - 1 = -|x|$; same x-intercepts (zeros), different y-intercepts, different orientation, one has a maximum value and one has a minimum value, same shape, vertex has same x-coordinate (h) and opposite y-coordinate (k)

3. a) $(x, y) \rightarrow \left(x, \frac{1}{4}y\right)$; $f(x) = \frac{1}{4}x^2$



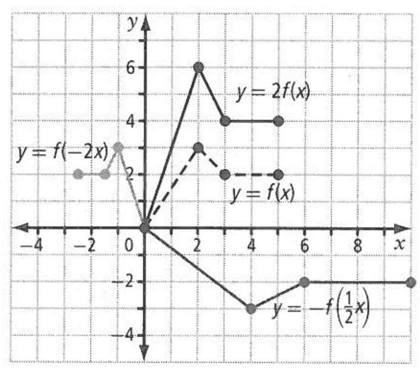
b) $(x, y) \rightarrow (2x, y)$; $f(x) = \left(\frac{1}{2}x\right)^2$



4. a) $\left(\frac{1}{2}x\right)^2 = \left(\frac{1}{2}\right)^2 (x)^2 = \frac{1}{4}x^2$

b) Example: Given $f(x) = x^2$, any horizontal stretch by a factor of p is equivalent to a vertical stretch by a factor of $\frac{1}{p^2}$.

5. a) $y = 2f(x)$ b) $y = -f\left(\frac{1}{2}x\right)$ c) $y = f(-2x)$



6. Answers may vary.

1.3 Combining Transformations, pages 18–25

1. Steps i) and ii) may be reversed and the answer will still be correct.

a) i) reflection in the y-axis, ii) vertical stretch by a factor of 4, iii) translation 5 units down

b) i) horizontal stretch by a factor of $\frac{1}{2}$, ii) reflection in the x-axis, iii) translation 7 units to the left

c) i) horizontal stretch by a factor of 4, ii) vertical stretch by a factor of 1.75, iii) translation 1.5 units to the right

d) i) horizontal stretch by a factor of $\frac{1}{3}$ and reflection in the y-axis, ii) vertical stretch by a factor of $\frac{1}{2}$ and reflection in the x-axis, iii) translation 3 units up and 1 unit to the left

2. **a)** $y + 7 = -f\left(\frac{1}{6}x\right)$

b) $y = \frac{1}{2}|-(x - 3)|$

c) $y + 4 = -\frac{1}{9}(x - 10)^2$ or $y + 4 = -\left[\frac{1}{3}(x - 10)\right]^2$

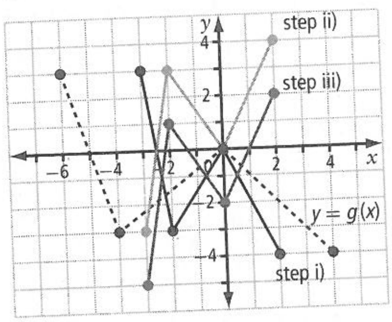
3. **a)** (6, 6)

b) (−11, −10)

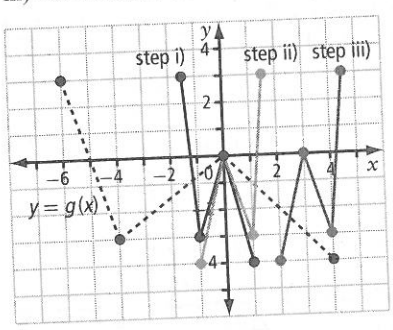
c) (18, 30)

4. (3, −12), (−14, 8), and (24, −24)

5. **a)** i) horizontal stretch by a factor of $\frac{1}{2}$, ii) reflection in the x-axis, iii) translation 2 units down

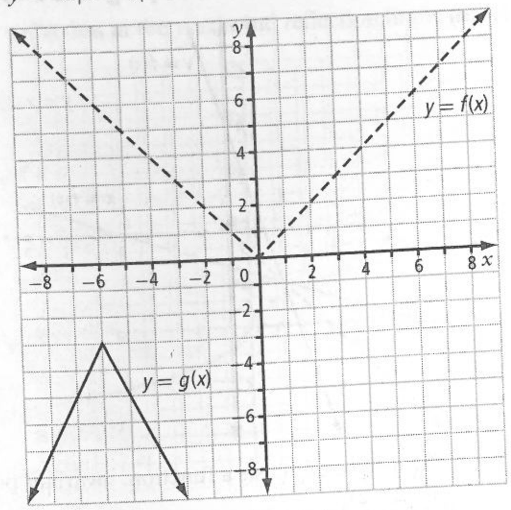


b) i) horizontal stretch by a factor of $\frac{1}{4}$,
ii) reflection in the y-axis,
iii) translation 3 units to the right



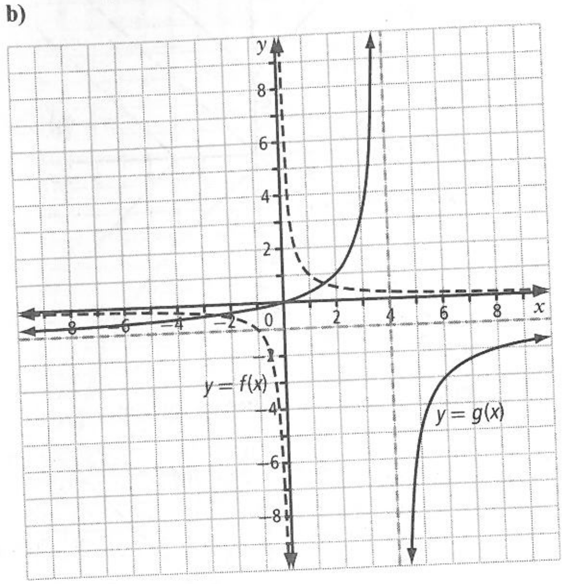
6. **a)** $y = -2|x + 6| - 3$

b)



7. **a)** $y = -\frac{1}{\frac{1}{4}(x - 4)} - 1$ or $y = -\frac{4}{x - 4} - 1$

b)



8. $y - 7 = -2f(x + 5)$

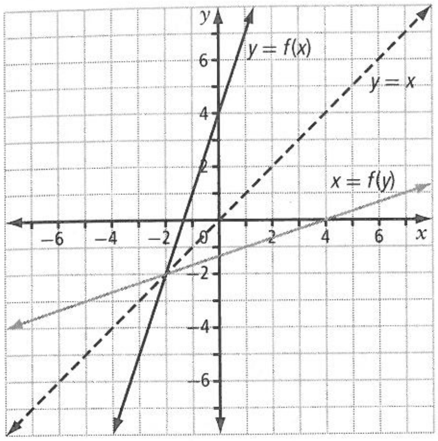
9. $y = 2f\left(-\frac{1}{2}x\right)$

10. $y = f(-2x) + 3$

11. Answers may vary.

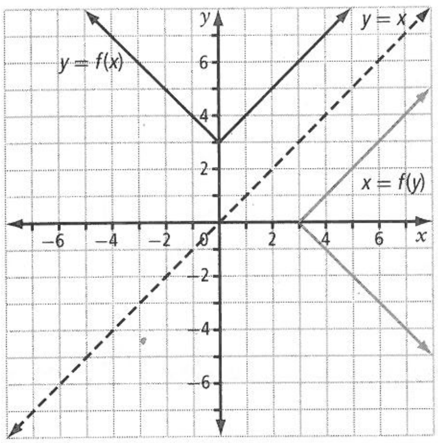
1.4 Inverse of a Relation, pages 26–34

1\. a)



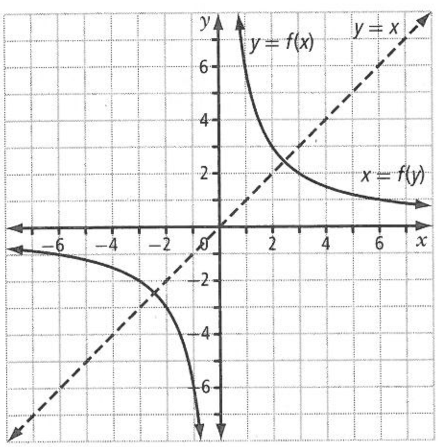
The inverse of $f(x)$ is a function; invariant point at (−2, −2).

b)



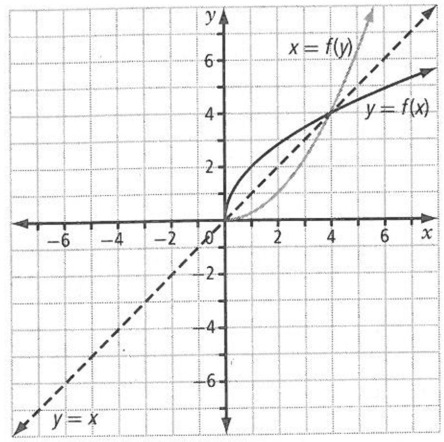
The inverse of $f(x)$ is not a function.

c)



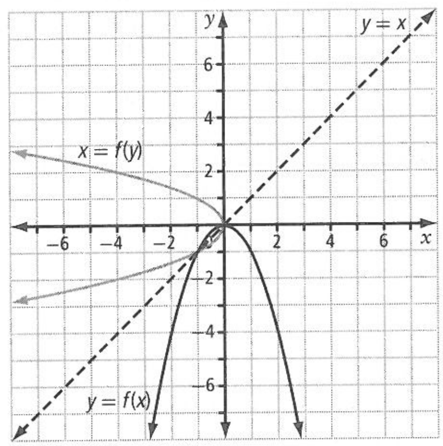
The inverse of $f(x)$ is a function; invariant points at approximately (2.5, 2.5) and (−2.5, −2.5).

d)



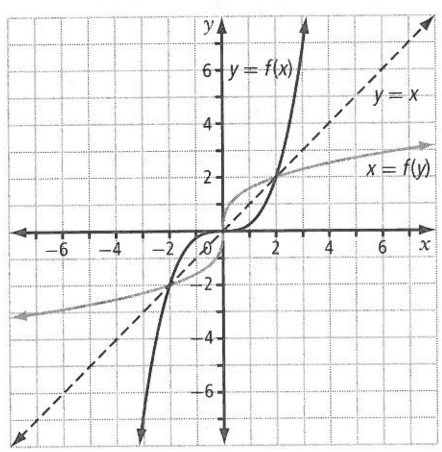
The inverse of $f(x)$ is a function; invariant points at (0, 0) and (4, 4).

e)



The inverse of $f(x)$ is not a function; invariant points at (−1, −1) and (0, 0).

f)



The inverse of $f(x)$ is a function; invariant points at (−2, −2), (0, 0), and (2, 2).

2. a) $f^{-1}(x) = x + 4$ b) $f^{-1}(x) = -\frac{1}{6}x - \frac{1}{3}$
c) $f^{-1}(x) = \frac{5}{3}x + 5$ d) $f^{-1}(x) = 2x - 6$

3. Examples: **a)** $\{x \mid x \geq 2, x \in \mathrm{R}\}$ or $\{x \mid x \leq 2, x \in \mathrm{R}\}$
b) $\{x \mid x \geq -4, x \in \mathrm{R}\}$ or $\{x \mid x \leq -4, x \in \mathrm{R}\}$

4. a) For $f(x) = -x^2 + 6, x \geq 0$, the inverse is $f^{-1}(x) = \sqrt{-(x - 6)}$. For $f(x) = -x^2 + 6, x \leq 0$, the inverse is $f^{-1}(x) = -\sqrt{-(x - 6)}$.
b) For $f(x) = \frac{1}{2}x^2 + 4, x \geq 0$, the inverse is $f^{-1}(x) = \sqrt{2(x - 4)}$. For $f(x) = \frac{1}{2}x^2 + 4, x \leq 0$, the inverse is $f^{-1}(x) = -\sqrt{2(x - 4)}$.

5. $y = \pm\sqrt{x + 2} - 3$

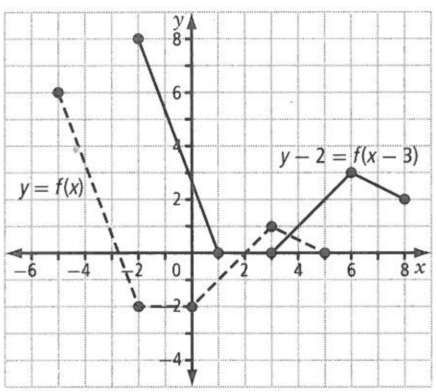
6. a) $42 < x < 105$
b) $f^{-1}(x) = \sqrt{\dfrac{x}{0.01634}} + 26.643$, where x = CRL, in millimetres
c) 14.3 weeks

7. Answers may vary.

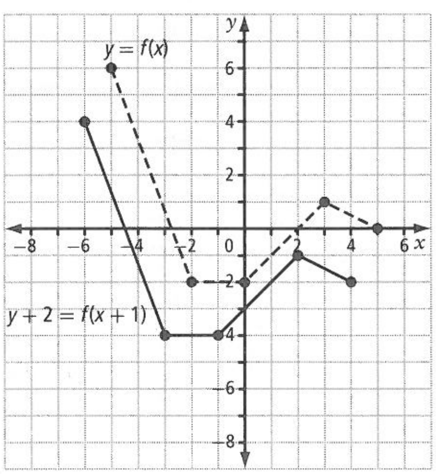
Chapter 1 Review, pages 35–37

1. a) $y + 3 = |x - 5|$ b) $y - 1 = |x + 4|$

2. a)

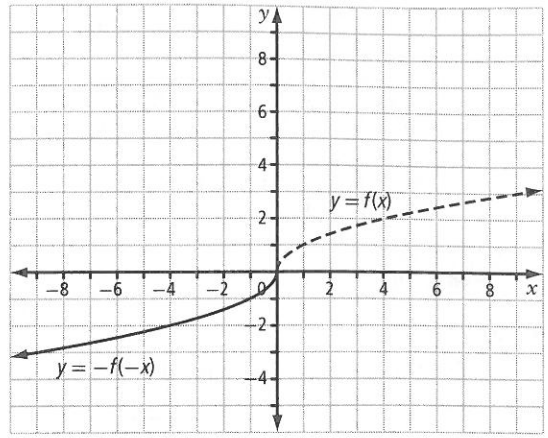


b)

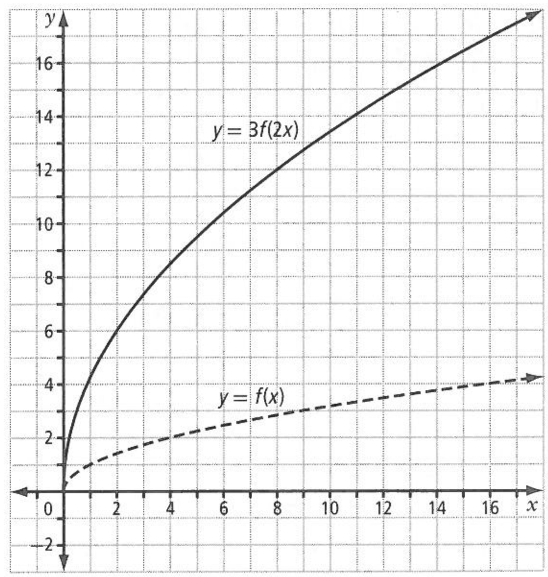


3. a) (12, 5) b) (−3, −5) c) (36, −10)

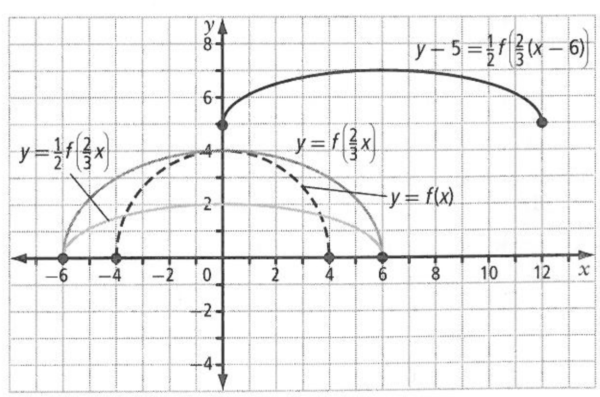
4. a) reflection in the y-axis and reflection in the x-axis



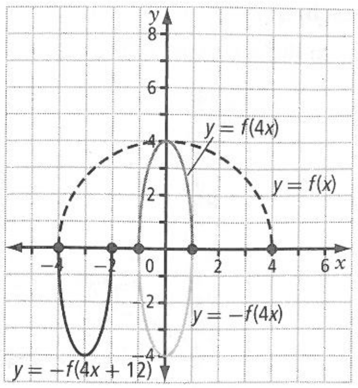
b) horizontal stretch by a factor of $\frac{1}{2}$, vertical stretch by a factor of 3



5. a)



b)



6. a) $f^{-1}(x) = -2x + 10$

   b) Example: restricted domain of $f(x)$: $\{x \mid x \geq 1, x \in R\}, f^{-1}(x) = \sqrt{\frac{1}{2}x} + 1$

Chapter 2

2.1 Radical Functions and Transformations, pages 39–46

1. a) vertical stretch by a factor of 3, reflection in the y-axis, translation 4 units left and 2 units down; domain: $\{x \mid x \leq -4, x \in R\}$; range: $\{y \mid y \geq -2, y \in R\}$

   b) vertical stretch by a factor of 2, reflection in the x-axis, horizontal stretch by a factor of $\frac{1}{4}$, translation of 3 units right and 5 units up; domain: $\{x \mid x \geq 3, x \in R\}$; range: $\{y \mid y \leq 5, y \in R\}$

   c) vertical stretch by a factor of 4, horizontal stretch by a factor of $\frac{1}{5}$, translation of 1 unit left and 4 units down; domain: $\{x \mid x \geq -1, x \in R\}$; range: $\{y \mid y \geq -4, y \in R\}$

   d) horizontal stretch by a factor of $\frac{1}{3}$, reflection in the x-axis and y-axis, translation 2 units left; domain: $\{x \mid x \leq -2, x \in R\}$; range: $\{y \mid y \leq 0, y \in R\}$

2. a) $y = -3\sqrt{x - 4} - 2$

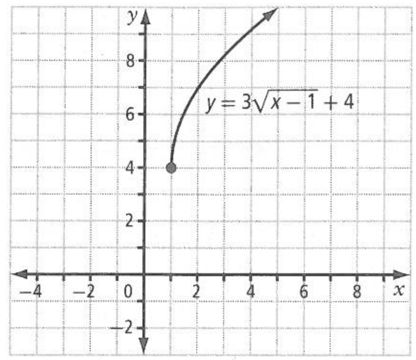
   b) $y = \sqrt{-4(x + 5)} + 3$

   c) $y = 2\sqrt{\frac{1}{3}(x + 4)} + 1$

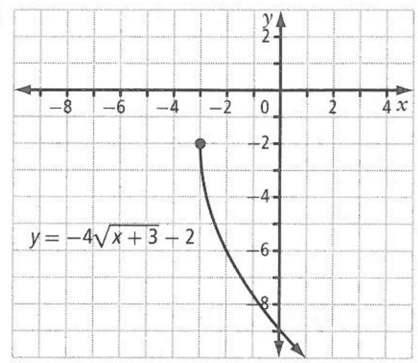
   d) $y = -3\sqrt{-2(x + 6)}$

3. a) B b) C c) D d) A

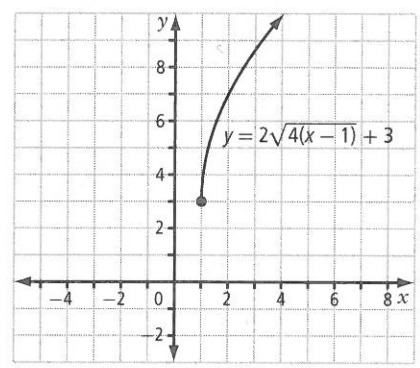
4. a)



b)



c)



d)