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Chapter 2 Answers

Prerequisite Skills

1. a) Answers may vary. Sample answer: stretched as $a > 1$; the parabola opens downward because of the negative prefix

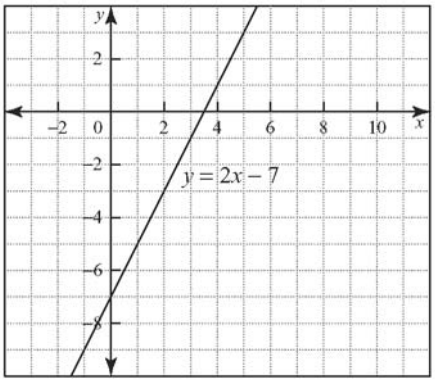
b) Answers may vary. Sample answer: compressed as $a < 1$; the parabola opens upward because $a > 0$

c) Answers may vary. Sample answer: stretched as $a > 1$; the parabola opens downward because of the negative prefix

d) Answers may vary. Sample answer: compressed as $a < 1$; the parabola opens upward because $a > 0$

2. a) $(4, -4)$ **b)** $(-3, 2)$ **c)** $(-5, 3)$ **d)** $\left(-1, -\frac{1}{2}\right)$

3. a)



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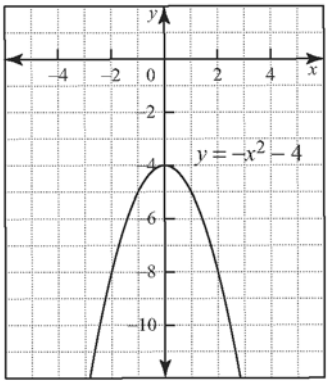

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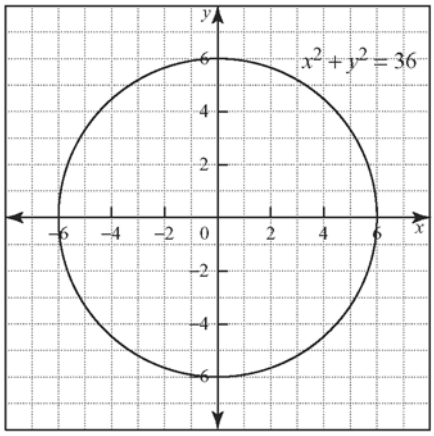
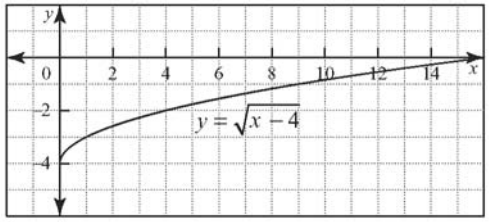
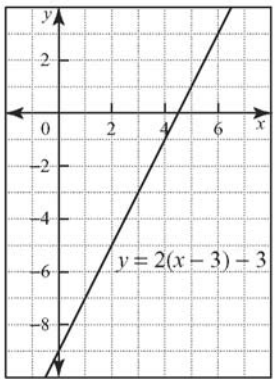


d)



4. a)



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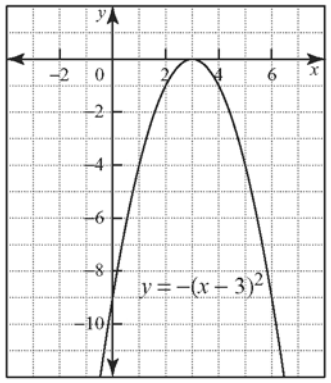

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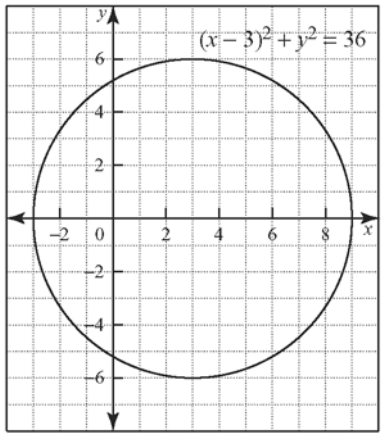

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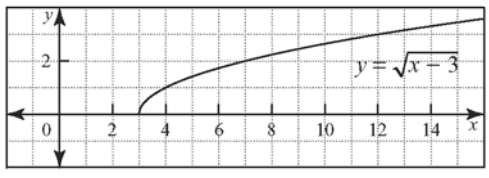

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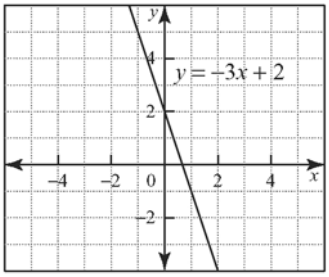
5. a)



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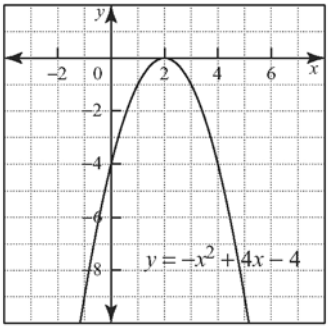

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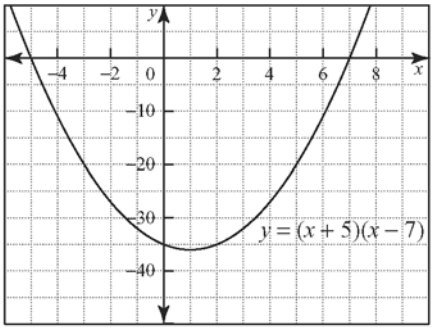
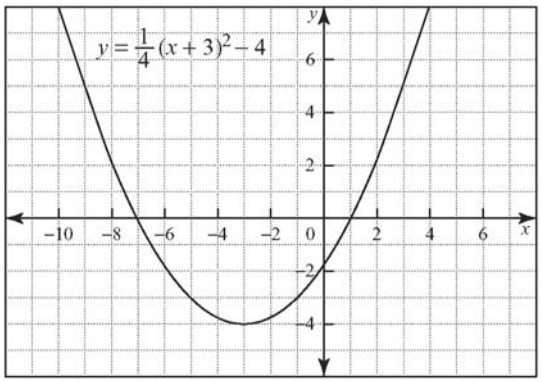


d)



6. a) $2x^2 - 10x$ **b)** $12x^3y - 28x^2y^2$
c) $-15y^3 + 10y^2 - 20y$ **d)** $6x^2 - 13x - 5$
e) $25x^2 - 4$ **f)** $32x^2 - 4x$

7. a) 12 **b)** 7 **c)** 20 **d)** $3x^2y$ **e)** $3y$ **f)** $x + 4$

8. a) $5x(5x + 1)$ **b)** $-7x^2y\,(4x - 7y)$
c) $3x^2y^3(2x - 3y)$ **d)** $-2x^4y^2\,(5x - 6)$
e) $(x + 3)(5x + y)$ **f)** $(x - 3)(2 - 10y)$

9. a) $(x + 1)(x + 4)$ **b)** $(x - 3)(x - 6)$
c) $(x + 1)(x + 1)$ **d)** $3(x - 3)(x + 3)$
e) $-2(x + 8)(x - 2)$ **f)** $7(x - 5)(x - 3)$
g) $-3(x + 2)(x + 2)$ **h)** $4(x^2 + 9)$

10. a) $(2x - 3)(x - 4)$ **b)** $(3x + 1)(3x - 5)$
c) $(5x + 3)(x - 1)$ **d)** $(x - 4)(2x - 5)$
e) $(2x - 7)(5x + 1)$ **f)** $2(4x^2 - 35x + 24)$

11. a) 78 **b)** $18x^2y^2$ **c)** $(x - 3)(x + 3)(x + 1)$

12. a) $\frac{17}{12}$ **b)** $\frac{4}{15}$ **c)** $\frac{2x + 3y}{6}$ **d)** $\frac{21x - 10y}{35}$

13. a) $-\frac{2}{15}$ **b)** $\frac{5}{3}$ **c)** $\frac{\sqrt{13}}{8}$ **d)** $-\frac{25\sqrt{3}}{64\sqrt{2}}$

14. a) $l = \frac{P - 2w}{2}$ **b)** $x = \pm\sqrt{36 - y^2}$
c) $x = \pm\sqrt{\frac{y - 3}{2}}$ **d)** $w = \frac{V}{lh}$
e) $r = \sqrt[3]{\frac{3V}{4\pi}}$ **f)** $x = \pm\sqrt{\frac{y^2 - 3}{2}}$

2.1 Functions and Equivalent Algebraic Expressions

1. a) $\frac{1}{x + 2}$, $x \neq 3, -2$ **b)** $\frac{1}{x + 4}$, $x \neq -4, -5$
c) $\frac{x - 1}{x + 3}$, $x \neq -3, -4$ **d)** $\frac{x + 3}{x - 5}$, $x \neq 3, 5$

2. a) −2, 1, 10, 86

b) impossible, $-\frac{2}{15}, -\frac{1}{8}$, impossible. Answers may vary.
Sample answer: The x-values −3 and 5 are not possible because division by zero is not defined, and the expression in the denominator is zero for these values.

c) $0, \frac{1}{2}, 0, \frac{16}{7}$

3. a) $l = \frac{600}{w}$ **b)** $P = 2\left(\frac{600 + w^2}{w}\right)$ **c)** $w > 0$

4. a) Yes, with restrictions $x \neq -1, 2$
b) No, the correct simplification is
$h(x) = \frac{(2x - 1)(3x + 4)}{(x + 2)(6x - 1)}$, with restrictions $x \neq -2, \frac{1}{6}$
c) No, the expression cannot be simplified. There are no restrictions on x.
d) Yes, with restrictions $x \neq -5, \frac{3}{2}$

5. Answers may vary. Sample answer: The graph will look like the line $y = x - 1$, with an open hole at $x = -2$, because the function simplifies to $y = x - 1$, but has a restriction that $x \neq -2$.

6. a) $A = x^2 - 25$
b) domain $\{x \in \mathbb{R}, 0 < x < 5\}$,
range $\{A \in \mathbb{R}, 0 < A < 25\}$

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7. a) $l = 2x + 10$, $w = x$, $h = 2x$
b) $V = 2x^2(2x + 10)$, or $V = 4x^3 + 20x^2$
c) $x > 0$
d) for $x = 8$, $l = 26$, $w = 8$, $h = 16$; for $x = 15$, $l = 40$, $w = 15$, $h = 30$
e) for $x = 8$, 3328 m^3; for $x = 15$, 18 000 m^3

2.2 Skills You Need: Operations With Rational Expressions

1. a) $\frac{2x^2}{x-1}$, $x \neq 0, x \neq 1, x \neq \frac{4}{3}$

b) $\frac{x-4}{x}$, $x \neq -1, x \neq 0, x \neq \frac{3}{2}$

c) $\frac{(2x-5)(x+5)}{x}$, $x \neq 0, x \neq 1, x \neq 4$

d) $\frac{(x-1)(x^2-3x+4)}{(x-2)(x+2)(x+4)}$, $x \neq -4, x \neq -2, x \neq -1, x \neq 2$

2. a) $\frac{(x-2)^2}{x-3}$, $x \neq -3, x \neq -2, x \neq 3$

b) $\frac{x-3}{x-1}$, $x \neq -4, x \neq -3, x \neq 1, x \neq 2, x \neq 3$

c) $\frac{(x+1)(3x+2)}{(x+3)(3x-2)}$, $x \neq -3, x \neq -\frac{2}{3}, x \neq 0, x \neq \frac{2}{3}, x \neq 4$

d) $\frac{(x+1)(x+3)}{(x-4)}$, $x \neq -3, x \neq -\frac{3}{2}, x \neq 0, x \neq 4$

3. a) $\frac{2(3x+4)}{(x-3)(x+2)(x+1)}$, $x \neq -2, x \neq -1, x \neq 3$

b) $\frac{x(x+2)}{(x-3)(x+3)(x+4)}$, $x \neq -4, x \neq -3, x \neq 3$

c) $\frac{5x^2-9x+11}{(2x+1)(x-4)(x+1)}$, $x \neq -\frac{1}{2}, x \neq -1, x \neq 4$

d) $\frac{x-5}{(x+1)(x+2)(x+3)}$, $x \neq -3, x \neq -2, x \neq -1$

4. a) $\frac{2}{2x-1}$, $x \neq \frac{1}{2}$ **b)** $\frac{4x}{x-7}$, $x \neq 7$

c) $\frac{2x}{3x-4}$, $x \neq \frac{4}{3}$ **d)** $\frac{2(4x+1)}{5x-2}$ $x \neq \frac{2}{5}$

5. a) length $(60 - 2x)$ cm, width $(60 - 4x)$ cm, height x cm
b) $V = 8x^3 - 360x^2 + 3600x$
c) $SA = -4(x^2 + 30x - 900)$
d) Answers may vary. Sample answer: Since a rectangle needs to be cut for there to be a height, $x > 0$, and since there must also be a width $60 - 4x > 0$, $x < 15$. Therefore, the restrictions on x are $0 < x < 15$.

6. Answers may vary. Sample answer: While the two expressions both simplify to $x + 2$, they differ in their restrictions. The first expression has the restriction $x \neq -3$ and the second has the restriction $x \neq \frac{1}{2}$.

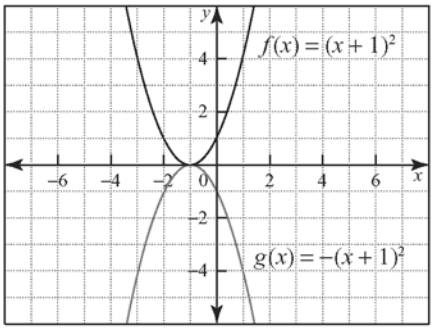
7. a) Joe: $80\left(t + \frac{1}{6}\right)$ km; Jimmy: vt km
b) $v = \frac{40(6t+1)}{3t}$ **c)** 107 km/h

2.3 Horizontal and Vertical Translations of Functions

1. a) $f(x)$ moves 1 unit to the right and 3 units down
b) $f(x)$ moves 3 units to the right and 7 units up
c) $f(x)$ moves 1 unit to the left and 2 units up
2. a) (4, 1) **b)** (1, 1) **c)** (–2, 11) **d)** (0, 12)
3. Translate 4 units to the left and 3 units down.
4. a) $a(x) = \sqrt{x-3}$ **b)** $b(x) = \sqrt{x-1} + 5$
c) $c(x) = \sqrt{x} - 1$ **d)** $d(x) = \sqrt{x-4} + 2$
5. a) $a(x) = (x-2)^2 - 2$ **b)** $b(x) = x^2 + 3$
c) $c(x) = (x+1)^2 - 3$ **d)** $d(x) = (x-3)^2$
6. a) $a(x) = \frac{2}{x-2}$ **b)** $b(x) = \frac{2}{x} + 5$
c) $c(x) = \frac{2}{x+1} - 1$ **d)** $d(x) = \frac{2}{x-3} + 2$
7. a) $x \geq 3$ **b)** $x \geq 1$ **c)** $x \geq 0$ **d)** $x \geq 4$

2.4 Reflections of Functions

1. a) $g(x) = -3(x-4)^2 - 5$ **b)** $g(x) = \sqrt{-2x-1}$
c) $g(x) = -\frac{2}{x+3} + 2$ **d)** $g(x) = \sqrt{4-3x} + 1$
2. a) $g(x) = -f(x)$, therefore a reflection in the x-axis
b) $g(x) = f(-x)$, therefore a reflection in the y-axis
c) $g(x)$ and $f(x)$ are not related by reflection, since $g(x) \neq -f(x)$ and $g(x) \neq f(-x)$
d) $g(x) = -f(-x)$, therefore a reflection in the x-axis and the y-axis
3. a)



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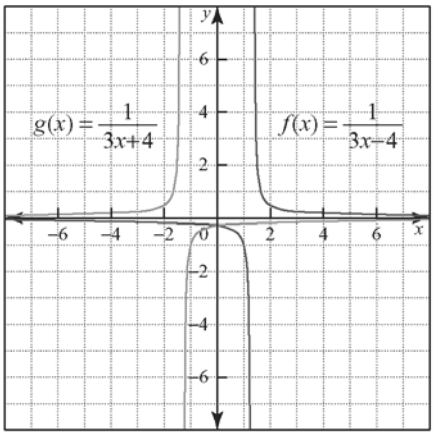
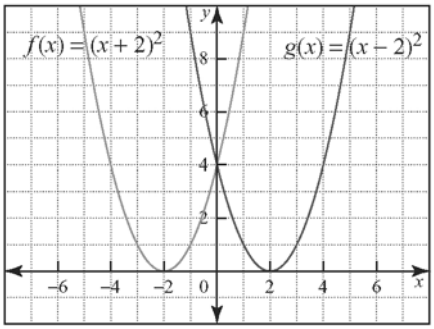
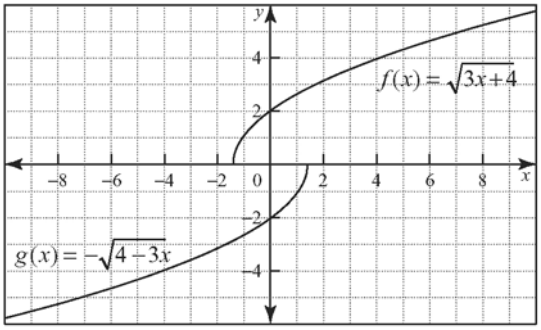
b)



c)

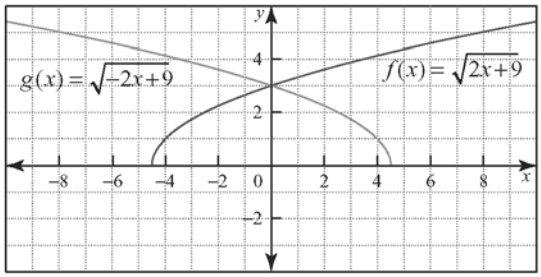


d)



4. $y = -x + 10$ for $x = 0$ to $x = 4$.

5. a)

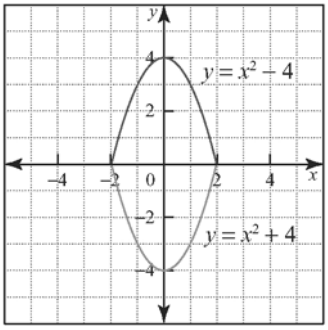


b) (0, 3)

c) Answers may vary. Sample answer: Under the reflection in the *y*-axis, the invariant point will occur at $x = 0$.

6. a) $x = -2, x = 2$

b)



2.5 Stretches of Functions

1. a) a vertical compression by a factor of $\frac{1}{2}$

b) a horizontal stretch by a factor of $\frac{3}{4}$

c) a vertical stretch by a factor of 4

d) a horizontal compression by a factor of $\frac{1}{2}$

2. Answers may vary. Sample answers:

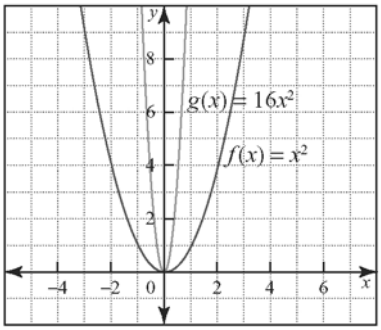
a) I: a horizontal stretch by a factor of 16

II: rewrite $g(x) = (4x)^2$, indicating a horizontal compression by a factor of $\frac{1}{4}$.

b) I: a horizontal stretch by a factor of 2

II: rewrite $g(x) = \frac{1}{4}x^2$, indicating a vertical compression by a factor of $\frac{1}{4}$.

3. a)



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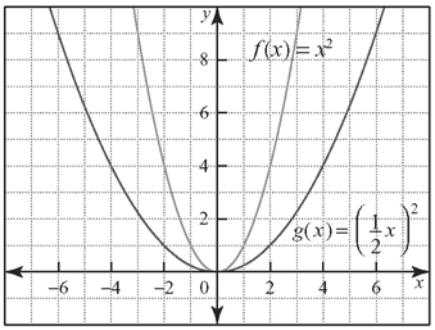
b)



4. a) a vertical stretch by a factor of 3
b) a horizontal stretch by a factor of 4

5. a) $h(t) = -4.9t^2 + 10$

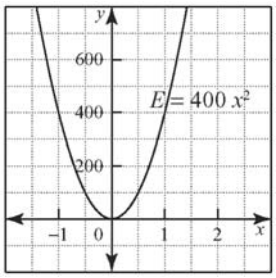
b) $h(t) = -\frac{4.9}{6}t^2 + 10$

c) Earth: 1.4 s, moon: 3.5 s. The difference is 2.1 s.

6. a) Answers may vary. Sample answer: The value of $\frac{k}{2}$ represents the vertical stretch of the function compared to $y = x^2$.

b) $E = 400x^2$

c)



Answers may vary. Sample answer: A negative value of x is a compression of the spring, which still stores energy in the spring. A positive value of x is a stretch of the spring, which also stores energy in the spring.

d) i) 25 J **ii)** 36 J **iii)** 64 J
e) i) 6.25 J **ii)** 9 J **iii)** 16 J

2.6 Combinations of Transformations

1. a) $a = 3, k = 1, d = 1, c = -2$

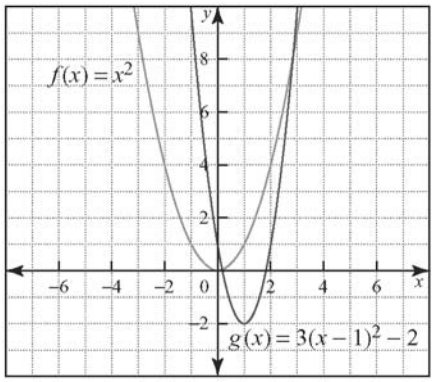
b) $a = \frac{2}{3}, \ k = 2, d = 3, c = 5$

c) $a = -2, k = 3, d = -3, c = -2$

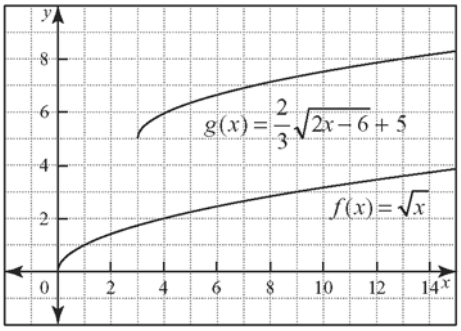
d) $a = 4, k = 2, d = \frac{1}{2}, \ c = 1$

2. Answers may vary. Sample answer: Any stretches, compression and/or reflection can be done in any order, but must be done before a translation.

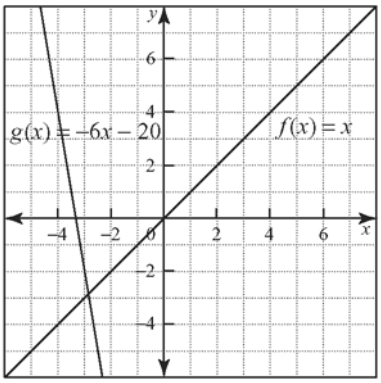
3. a)



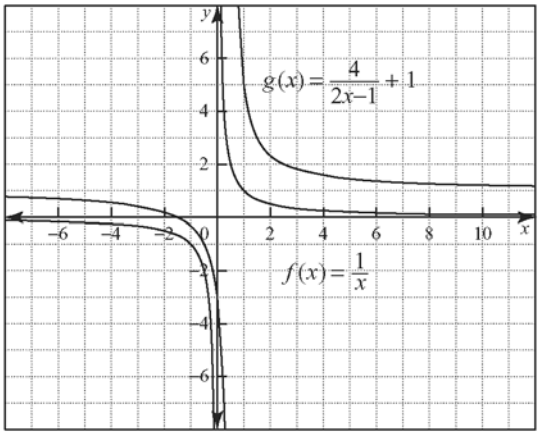
b)



c)



d)



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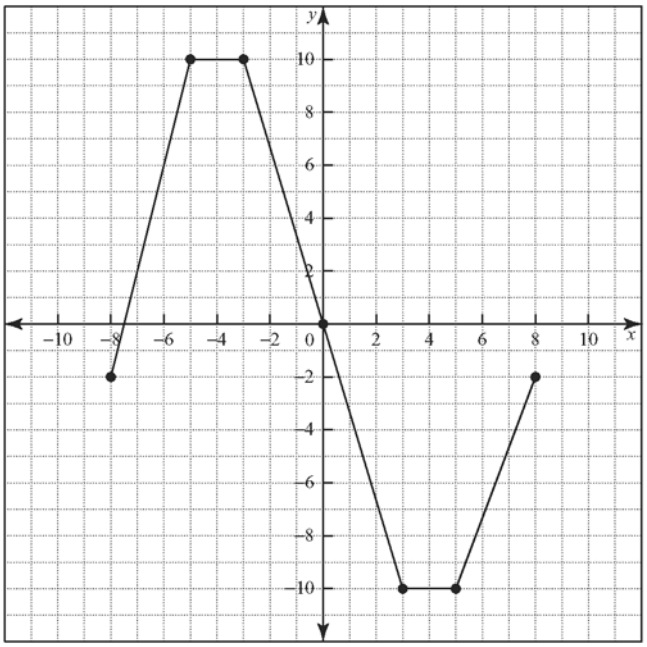
4. a)



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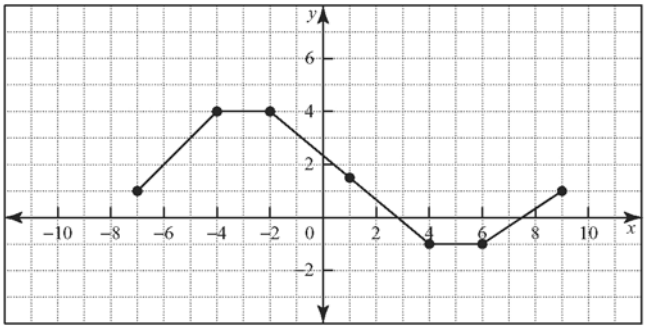
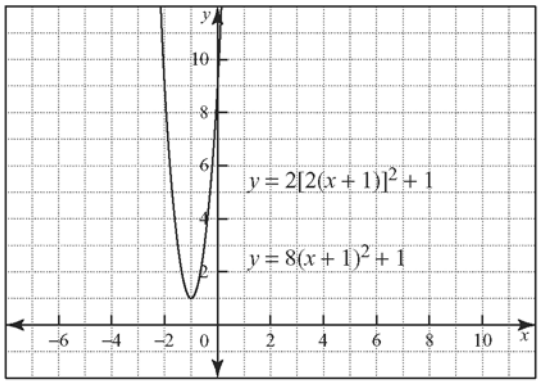


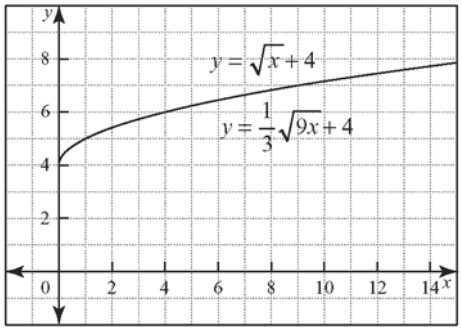
5. a) vertical stretch by a factor of 2, horizontal compression by a factor of $\frac{1}{2}$, horizontal translation 1 unit to the left, vertical translation 1 unit up
Simplified: $f(x) = 8(x + 1)^2 + 1$, with a vertical stretch by a factor of 8, a horizontal translation 1 unit to the left, and a vertical translation 1 unit up

b) vertical compression by a factor of $\frac{1}{3}$, horizontal compression by a factor of $\frac{1}{9}$ vertical translation 4 units up; Simplified: $f(x) = \sqrt{x} + 4$, with a vertical translation 4 units up

6. a)



b)



2.7 Inverse of a Function

1. a) $f^{-1}(x) = \frac{x + 4}{3}$ **b)** $f^{-1}(x) = -1 \pm \sqrt{\frac{x - 1}{3}}$

c) $f^{-1}(x) = (x + 1)^2 - 3$ **d)** $f^{-1}(x) = \frac{3}{x - 2} + 2$

2. a) $f(x)$: none, $f^{-1}(x)$: none
b) $f(x)$: none, $f^{-1}(x)$: $x \geq 1$
c) $f(x)$: $x \geq -3$, $f^{-1}(x)$: none
d) $f(x)$: $x \neq 2$, $f^{-1}(x)$: $x \neq 2$

3. a) Yes. When the x and y values are switched in $f(x)$ and the expression is solved for y, the new expression equals $g(x)$.
b) No. When the x and y values are switched in $f(x)$ and the expression is solved for y, the new expression does not equal $g(x)$.

4. a) $C = 60 + 0.20x$ **b)** $x = \frac{C - 60}{0.20}$

c) Answers may vary. Sample answer: The inverse represents the number of kilometres that you can drive the rental car in a day for a given cost.

5. Answers may vary. Sample answer: Jennifer has written a reciprocal function; this is not what $f^{-1}(x)$ means.

6. a) $f^{-1}(x) = 2 \pm \sqrt{\frac{x - 1}{3}}$

b) $f^{-1}(f(x)) = x$ **c)** $f\left(f^{-1}(x)\right) = x$

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d) Answers may vary. Sample answer: Yes, because any point on the line of reflection $y = x$ for a function and its inverse is invariant.

7. a) $f(x) = 0.7x$ **b)** $f^{-1}(x) = \dfrac{x}{0.7}$

c) Answers may vary. Sample answer: The inverse represents the original price as a function of the sale price of the TV.

Chapter 2 Review

1. a) $\dfrac{1}{x+2},\ x \neq -2$ **b)** $x + 1,\ x \neq 1$

2. a) Yes **b)** No

3. a) $\dfrac{(x+1)(2x-1)}{x+4},\ x \neq -4, x \neq -2, x \neq 3$

b) $\dfrac{(2x+3)(x+1)}{(x-1)^2},\ x \neq -4, x \neq -1, x \neq -\dfrac{2}{3},\ x \neq 1$

c) $1, x \neq -2, x \neq -1, x \neq 1, x \neq \dfrac{3}{2}$

4. a) $\dfrac{8x-31}{(x-7)(x-2)(x+1)},\ x \neq -1, x \neq 2, x \neq 7$

b) $\dfrac{2x^2-12x-11}{(x-1)(x-4)(x+6)},\ x \neq -6, x \neq 1, x \neq 4$

c) $\dfrac{8x-2}{2x-1},\ x \neq \dfrac{1}{2}$

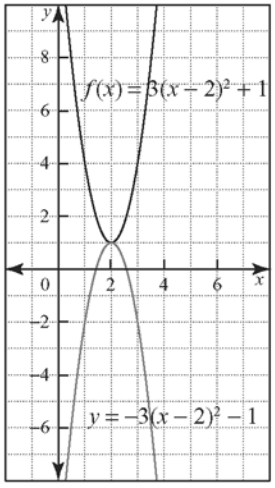
5. a) 50 mm **b)** $\dfrac{100(100-x)}{200-x}$ mm

6. a) (3, 9) **b)** (4, 3) **c)** (0, 6) **d)** (−1, −5)

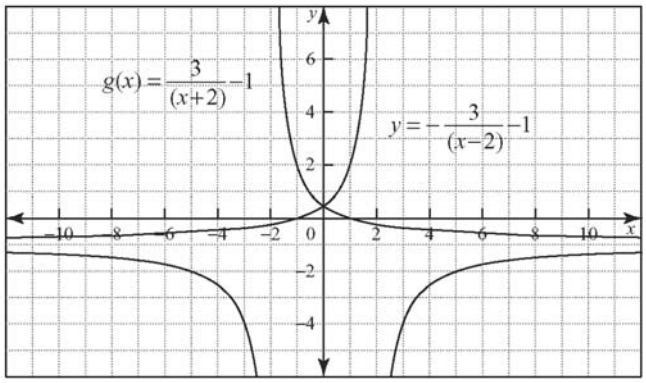
7. a) $g(x) = -2(x-6)^2 + 3$ **b)** $g(x) = -2(x-1)^2 + 5$

c) $-2(x-3)^2 + 4$ **d)** $g(x) = -2x^2$

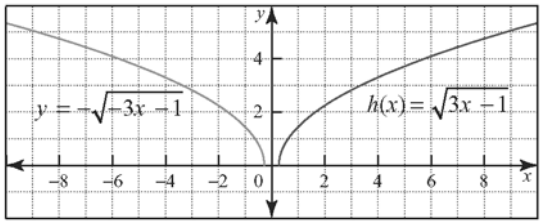
8. a)



b)



c)



9. a) $y = -3(x-2)^2 - 1$ **b)** $y = -\dfrac{3}{x-2} - 1$

c) $y = -\sqrt{-3x-1}$

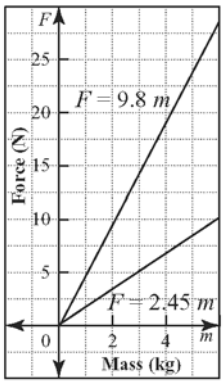
10. a) $g(x) = 3f(x)$ for $f(x) = x^2$; a vertical stretch by a factor of 3

b) $g(x) = f(5x)$ for $f(x) = \sqrt{x}$; a horizontal compression by a factor of $\dfrac{1}{5}$

c) $g(x) = \dfrac{1}{2}f\left(x\right)$ for $f(x) = \dfrac{1}{x}$; a vertical compression by a factor of $\dfrac{1}{2}$

d) $g(x) = f\left(\dfrac{4}{5}x\right)$ for $f(x) = x^2$; a horizontal stretch by a factor of $\dfrac{5}{4}$

11. a) and **d)**



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b) Answers may vary. Sample answer: The 9.8 is the vertical stretch factor compared to the function $F = m$.

c) $F = \frac{9.8}{4}m$, or $F = 2.25m$

12. a) a vertical stretch by a factor of 3, a horizontal compression by a factor of $\frac{1}{2}$, a horizontal translation 1 unit to the right, a vertical translation 2 units down

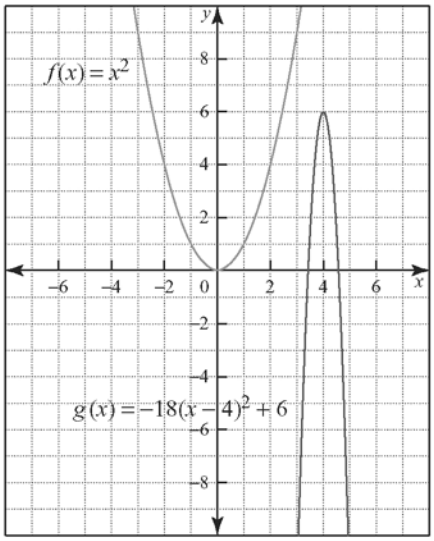
b) a vertical compression by a factor of $\frac{1}{4}$, a horizontal stretch by a factor of $\frac{5}{3}$, a horizontal translation 2 units to the left, a vertical translation 3 units up

13. a) $g(x) = -2\,[3(x-4)]^2 + 6$

b) $g(x) = -18(x-4)^2 + 6$

c) a reflection in the x-axis, a vertical stretch by a factor of 18, a horizontal translation 4 units to the right, a vertical translation 6 units up

d)



14. a) $f^{-1}(x) = x - 3$ **b)** $f^{-1}(x) = x^2 - 2$

c) $f^{-1}(x) = 2 \pm \sqrt{x}$ **d)** $f^{-1}(x) = \frac{1}{x+4} - 1$

15. a) 135° **b)** $n = \frac{360°}{180° - A}$

c) $n = 10$; therefore, a decagon

Chapter 2 Practice Test

1. B **2.** C **3.** D **4.** A **5.** B

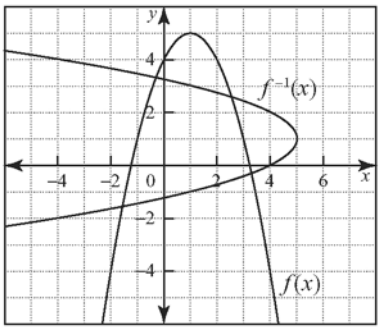
6. a) $\frac{5x-1}{(x+1)(x-1)(x-4)}$, $x \neq -1, x \neq 1, x \neq 4$

b) $\frac{-x^2 - 3x - 1}{(x+1)(x-4)(x+2)}$, $x \neq -2, x \neq -1, x \neq 4$

c) $\frac{x+4}{2x-5}$, $x \neq -2, x \neq -1, x \neq \frac{5}{2}, x \neq 3$

d) $\frac{(x-5)}{(x-1)}$, $x \neq 1, x \neq 5$

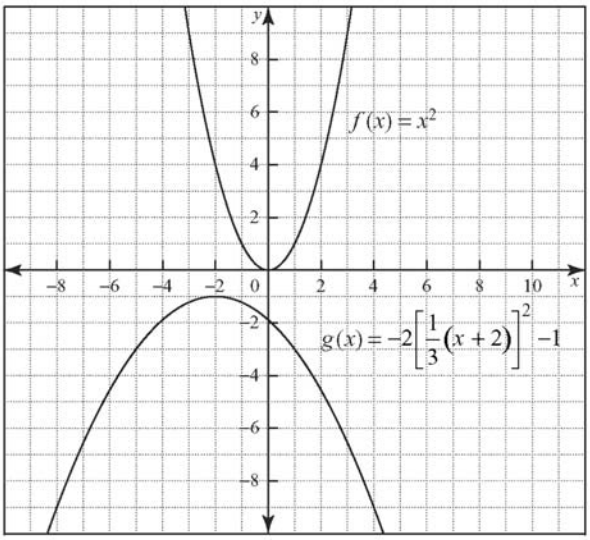
7.



Answers may vary. Sample answer: The inverse is not a function because it fails the vertical line test.

8. a) $g(x) = -2\left[\frac{1}{3}(x+2)\right]^2 - 1$

b)



c) domain $\{x \in \mathbb{R}\}$, range $\{y \in \mathbb{R}, y \leq -1\}$

9. a) $R = (50 + 2x)(200 - 5x)$

b) \$10 360 **c)** $0 \leq x < 40$

d) $x = 10 \pm \sqrt{\frac{11\,000 - R}{10}}$

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

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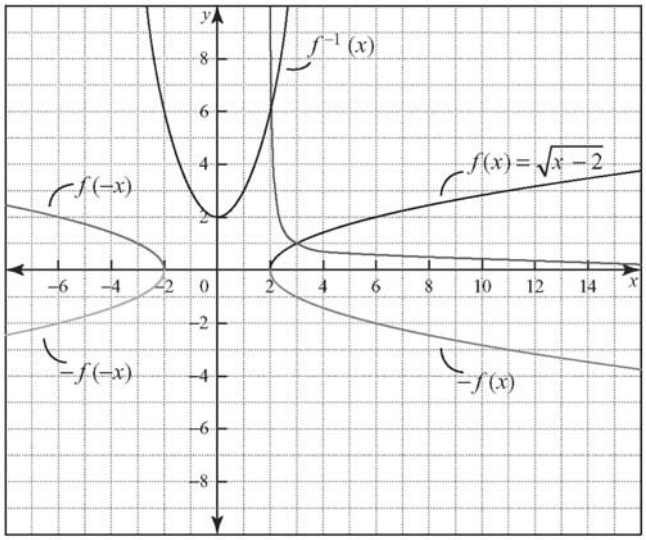
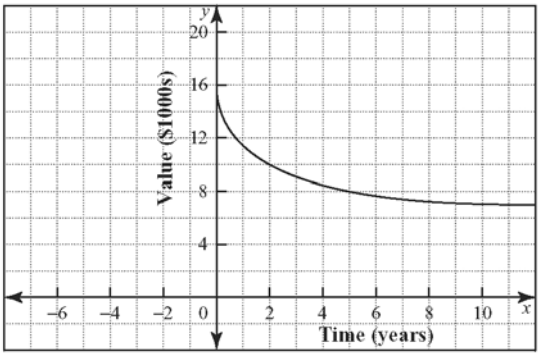
b)



11.



12. a) $T = 35x + 20$ **b)** 142.5 °C

c) $x = \dfrac{T - 20}{35}$ **d)** 2.3 km

13. Answers may vary. Sample answer: If the inverse of the function $f(x)$ includes the point (−3, 3), the function would have to include the point (3, −3). But since we are told that the original relation is a function that already includes a point with an x-coordinate of 3 in the point (3, 7), it cannot also include the point (3, −3). Therefore, the inverse cannot include the point (−3, 3).

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