Answer Key

Lesson 1: Creating and Solving Quadratic Equations in One Variable

Pre-Assessment, p. U3-1

1. d
2. c
3. a
4. d
5. a

Warm-Up 3.1.1, p. U3-6

1. The base of the ladder is about 7.75 feet from the house.
2. The ladder reaches about 14.94 feet up the side of the house.

Practice 3.1.1 A: Taking the Square Root of Both Sides, p. U3-16

1. $x = \pm 9$
2. no real solutions
3. $x = \pm 3$
4. $x = -4$ and $x = -2$
5. no real solutions
6. $x = 12.5$ and $x = 7.5$
7. A quadratic equation in the form $ax^2 + b = c$ has two real, rational solutions when $\frac{c-b}{a}$ is a positive perfect square.
8. $s = 2\sqrt{10} \approx 6.32$ centimeters
9. $r = \frac{\sqrt{60\pi}}{\pi} \approx 4.37$ millimeters
10. $a = \frac{10\sqrt{3}}{3} \approx 5.77$ inches

Practice 3.1.1 B: Taking the Square Root of Both Sides, p. U3-17

1. $x = \pm 2$
2. no real solutions
3. no real solutions
4. $x = 4 \pm 2\sqrt{10}$
5. $x = -6$
6. $x = 5 \pm \sqrt{7}$
7. A quadratic equation in the form $ax^2 + b = c$ has only one real solution when $c = b$.
8. $s = 7$ inches
9. $r = 2\sqrt{5} \approx 4.47$ units
10. $r = \pm\frac{\sqrt{5\pi}}{\pi} \approx 1.26$ feet

Warm-Up 3.1.2, p. U3-18

1. There are four possible sets of dimensions:
   $l = 30$ in, $w = 1$ in
   $l = 15$ in, $w = 2$ in
   $l = 10$ in, $w = 3$ in
   $l = 6$ in, $w = 5$ in
2. $w = 5x$ inches
3. $l = 10x^2y$ inches

Practice 3.1.2 A: Factoring Expressions by the Greatest Common Factor, p. U3-33

1. $x^2(3x + 5)$
2. $2xy\,(x - 4y)$
3. $y^2(y^2 + 2)$
4. no common factor
5. $xy^2(x^2 - 2xy + 5)$
6. $7x(1 - 3xy)$
7. $15x^2y$
8. $5x^3 + 11y^2$
9. Samuel did not factor out the greatest common number from each term. He factored out a 2, but he should have factored out a 4.
10. Ariana did not factor out the correct common powers of the variables. She factored out xyz^2, when she should have factored out xyz.

Practice 3.1.2 B: Factoring Expressions by the Greatest Common Factor, p. U3-34

1. $s(s^2t^2 - 3s + 2t^2)$
2. $2x^3y(2 + x^2y^2)$
3. no common factor
4. $xy(x^3 + x^2y + xy^2 + y^3)$
5. no common factor
6. $x^4(1 + x^{10})$
7. $13x^3y - 6z^2$
8. length: $3x^2$ feet; width: $(x^2 - 4x + 5)$ feet
9. $17x^3 + 24y^2$ cannot be factored because there are no common numbers or common variables between the two terms.
10. $(3a^2b^3 - 4c^2 + 12)$ meters

Warm-Up 3.1.3, p. U3-35

1. $(x^2 + 8x + 15)$ square feet
2. $(x^2 - 16)$ square feet
3. $(x + 7)$ feet

Practice 3.1.3 A: Factoring Expressions with *a* = 1, p. U3-55

1. $(y + 10)(y - 10)$
2. $(x - 7)(x - 2)$
3. $(x + 8)^2$
4. not factorable
5. $7(a - 2)(a + 2)$
6. $4(x + 9)(x - 1)$
7. $6(x + 3y)(x - 3y)$
8. $(a - 7)$ feet and $(a - 7)$ feet
9. $(2x + 5)$ meters and $(2x - 5)$ meters
10. $(y + 5)$ inches and $(y - 2)$ inches

Practice 3.1.3 B: Factoring Expressions with *a* = 1, p. U3-56

1. $(n + 6)(n - 6)$
2. $(x - 5)(x - 4)$
3. $(y - 10)^2$
4. not factorable
5. $8(b + 1)(b - 1)$
6. $5(x + 4)(x - 2)$
7. $10(n + 3m)(n - 3m)$
8. $(n - 12)$ feet and $(n - 12)$ feet
9. $(3y + 10)$ meters and $(3y - 10)$ meters
10. $(x + 9)$ inches and $(x - 2)$ inches

Warm-Up 3.1.4, p. U3-57

1. $(x + 1)$ inches
2. $(x + 4)$ inches and $(x + 6)$ inches
3. The width is 8 inches larger than the length.

Practice 3.1.4 A: Factoring Expressions with *a* > 1, p. U3-78

1. $(5x + 7)(3x - 1)$
2. $(3n + 2)(n + 8)$
3. $(2y - 7)(2y - 9)$
4. $(3x - 4)(x + 5)$
5. $3(a + 4)(a + 9)$
6. $(5n + 2)^2$
7. $2(2y - 7)(3y - 1)$
8. length = $(3x + 7)$ inches; width = $(3x + 7)$ inches
9. length = $(5x - 1)$ feet; width = $(x + 3)$ feet
10. length = $(3x - 2)$ meters; $(2x + 7)$ meters

Practice 3.1.4 B: Factoring Expressions with *a* > 1, p. U3-79

1. $(2x + 3)(4x - 7)$
2. $(8a - 3)(a + 2)$
3. $(2y + 5)(5y - 1)$
4. $(2x - 7)(x - 7)$
5. $(4a - 3)^2$
6. $5(x + 3)(x + 6)$
7. $2(5y - 1)(3y + 4)$
8. length = $(3x + 10)$ inches; width = $(2x + 1)$ inches
9. length = $(3x - 2)$ feet; width = $(x + 8)$ feet
10. length = $(5x - 3)$ meters; width = $(2x - 3)$ meters

Warm-Up 3.1.5, p. U3-80

1. $x - 8$
2. $x = 20$ feet
3. 25 feet
4. 1,500 cubic feet

Practice 3.1.5 A: Solving Quadratic Equations by Factoring, p. U3-96

1. $x = -6$, $x = 8$
2. $y = \frac{5}{2}$, $y = -7$
3. $n = 0$, $n = \frac{9}{5}$
4. $x = 4$, $x = -4$
5. $y = 5$, $y = 3$
6. $a = \frac{7}{2}$, $a = -\frac{1}{3}$
7. $x = 10$, $x = -6$
8. 0.375 second
9. 2 seconds
10. 5 seconds

Practice 3.1.5 B: Solving Quadratic Equations by Factoring, p. U3-97

1. $x = 4$, $x = 9$
2. $y = -2$, $y = -\frac{7}{3}$
3. $b = 0$, $b = \frac{11}{2}$
4. $x = 2$, $x = -2$
5. $y = -1$, $y = 8$
6. $n = -\frac{4}{3}$, $n = -\frac{1}{2}$
7. $x = 3$, $x = 8$
8. 1.25 seconds
9. 2 seconds
10. 4 seconds

Warm-Up 3.1.6, p. U3-98

1. The area of the patio is $(36x^2)$ ft^2.
2. The total area of the patio is $(36x^2 + 48x + 16)$ ft^2.

Practice 3.1.6 A: Completing the Square, p. U3-109

1. $c = 81$
2. $c = 144$
3. $c = \frac{225}{4}$
4. $c = \frac{1}{4}$
5. $x = -10$ and $x = 0$
6. $x = -13$ or $x = 1$
7. $x = -\frac{1}{3} \pm \frac{\sqrt{22}}{3}$
8. approximately 6.89 feet; you cannot have a negative length of a porch, so only one value of *x* is reasonable.
9. after approximately 2.12 seconds; the negative answer represents time before the ball was kicked, so only one value of *x* is reasonable.
10. approximately 31.36 mph and approximately 88.64 mph

Practice 3.1.6 B: Completing the Square, p. U3-110

1. $c = 121$
2. $c = 2500$
3. $c = \frac{81}{4}$
4. $c = \frac{4}{25}$
5. $x = 4 \pm \sqrt{14}$

6. $x = -\frac{1}{2} \pm \frac{\sqrt{11}}{2}$
7. $x = 3$ and $x = -7$
8. 8.81 feet; you cannot have a negative length, so only one value of x is reasonable.
9. after about 2.5 seconds; the negative answer represents time before the ball was kicked, so only one value of x is reasonable.
10. approximately 13.49 mph and approximately 61.51 mph

Warm-Up 3.1.7, p. U3-111

1. The area of the triangular patch is $4\sqrt{3}$ square inches, or about 6.93 square inches.
2. The amount of fabric needed for the 3 additional patches is $12\sqrt{3}$ square inches, or about 20.78 square inches.

Practice 3.1.7 A: Applying the Quadratic Formula, p. U3-123

1. 0; one real, rational solution
2. 1; two real, rational solutions
3. $x = \frac{3 \pm \sqrt{41}}{4}$
4. $x = -4 \pm 4\sqrt{2}$
5. no real solutions
6. $x = \frac{3}{2}$ and $x = -17$
7. after approximately 1.96 seconds
8. $10
9. after approximately 1.30 seconds
10. The discriminant, or the part of the quadratic formula under the radical, tells the number and type of roots of a quadratic equation.

Practice 3.1.7 B: Applying the Quadratic Formula, p. U3-124

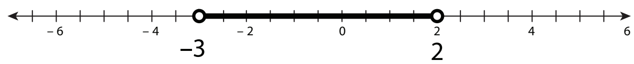
1. 13; two real, irrational solutions
2. –80; no real solutions
3. $x = -1$
4. $x = -\frac{5}{3}$ or $x = -1$
5. no real solutions
6. $x = 1$ or $x = -\frac{12}{7}$
7. after approximately 8.57 seconds
8. approximately $5.37 and approximately $18.63
9. after approximately 1.58 seconds
10. No, if a quadratic has two solutions, they must both be real or both be non-real.

Warm-Up 3.1.8, p. U3-125

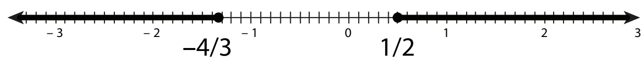
1. $0.6p + 0.3r \le 240$
2. The workers can assemble 600 racing games at the most.

Practice 3.1.8 A: Solving Quadratic Inequalities, p. U3-139

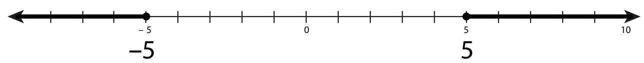
1. $-3 < x < 2$



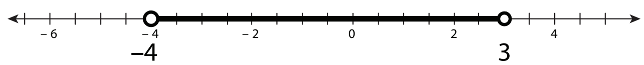
2. $x \le -\frac{4}{3}$ or $x \ge \frac{1}{2}$



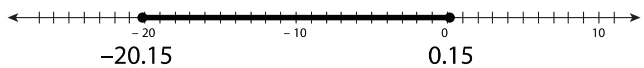
3. $x \le -5$ or $x \ge 5$



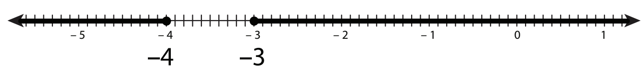
4. $-4 < x < 3$



5. $-20.15 \le x \le 0.15$



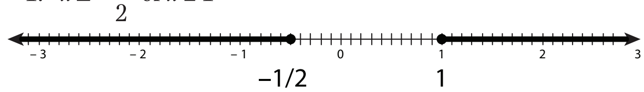
6. $x \le -4$ or $x \ge -3$



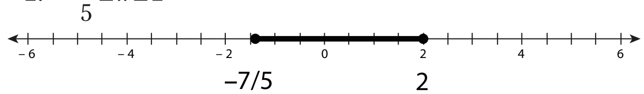
7. no solution
8. from 0.29 second to 1.71 seconds into the jump
9. from 0.28 second to 0.72 second into the dive
10. at speeds below 18.76 miles per hour

Practice 3.1.8 B: Solving Quadratic Inequalities, p. U3-140

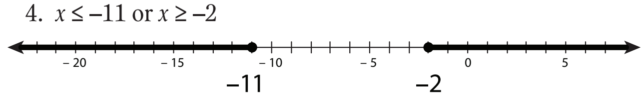
1. $x \le -\frac{1}{2}$ or $x \ge 1$



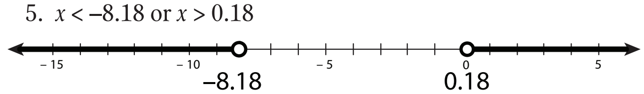
2. $-\frac{7}{5} \le x \le 2$



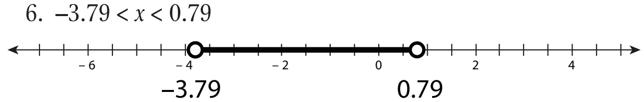
3. no real solutions
4. $x \le -11$ or $x \ge -2$



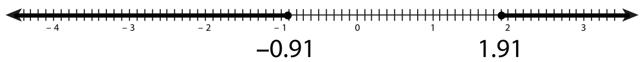
5. $x < -8.18$ or $x > 0.18$



6. $-3.79 < x < 0.79$



7. $x \le -0.91$ or $x \ge 1.91$



8. from 0.12 second to 8.45 seconds after takeoff
9. The balloon is never more than 6 feet above the ground.
10. The time of a complete swing will be greater than 4.49 seconds.

Progress Assessment, p. U3-141

1. a
2. b
3. b
4. a
5. c
6. c
7. a
8. d
9. c
10. b
11. Methods may vary. Recommended methods are listed.
    a. Solve by factoring; $x = -1$ or $x = -19$
    b. Solve by completing the square; $x = -10 \pm \sqrt{85}$
    c. Solve by using the quadratic formula; $x = \dfrac{-10 \pm \sqrt{79}}{3}$
    d. Solve by taking square roots; $x = \pm \dfrac{\sqrt{5}}{3}$

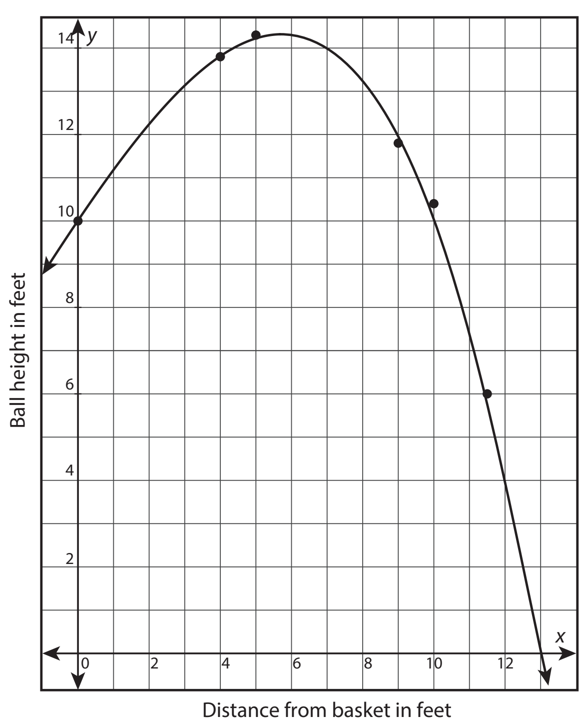
Lesson 2: Creating Quadratic Equations in Two or More Variables

Pre-Assessment, p. U3-143

1. b
2. b
3. a
4. d
5. c

Warm-Up 3.2.1, p. U3-146

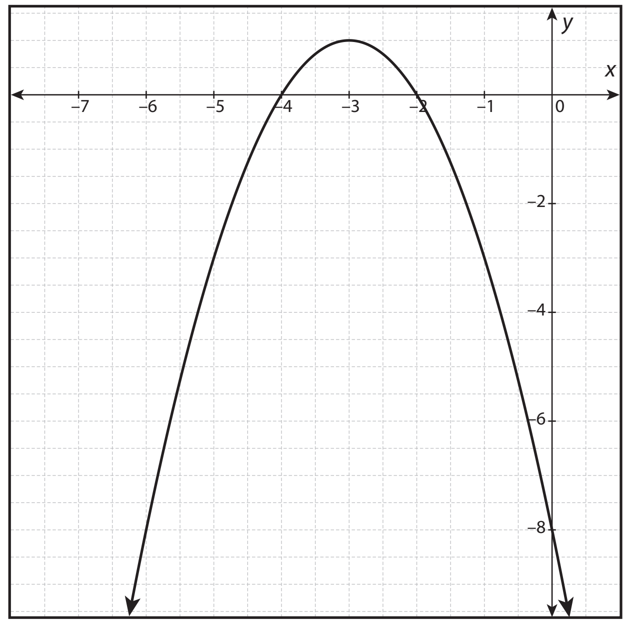
1.



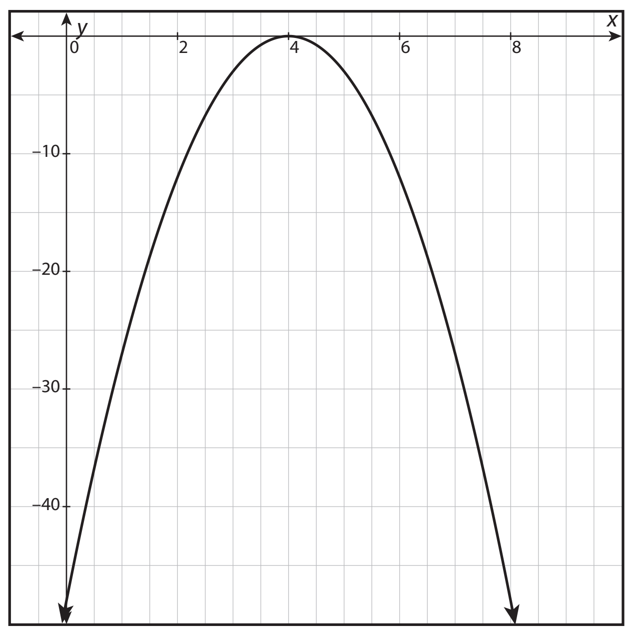
2. The ball will be about 13.5 feet high.

Practice 3.2.1 A: Creating and Graphing Equations Using Standard Form, p. U3-172

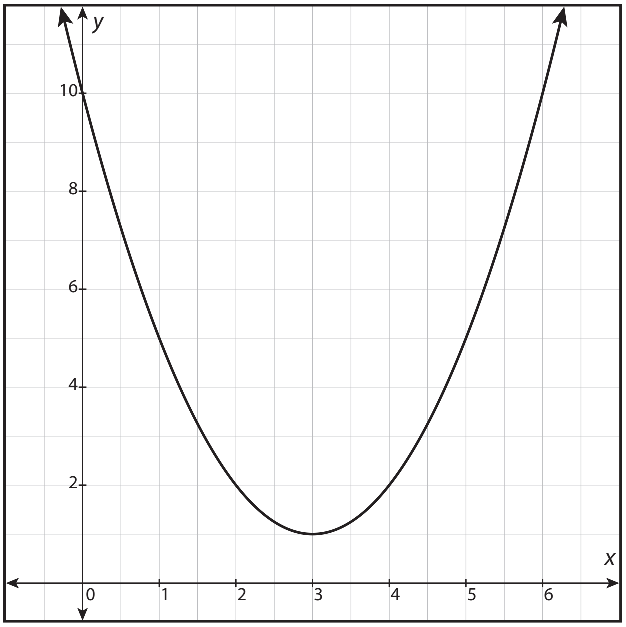
1.



2.



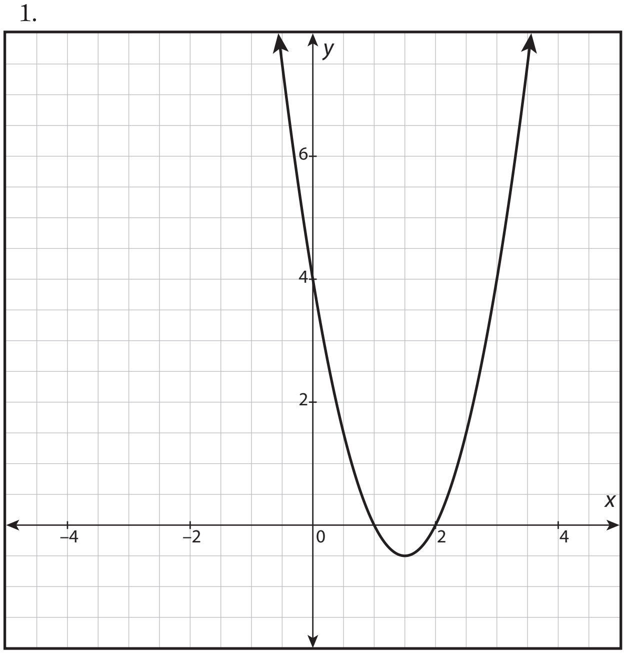
3.



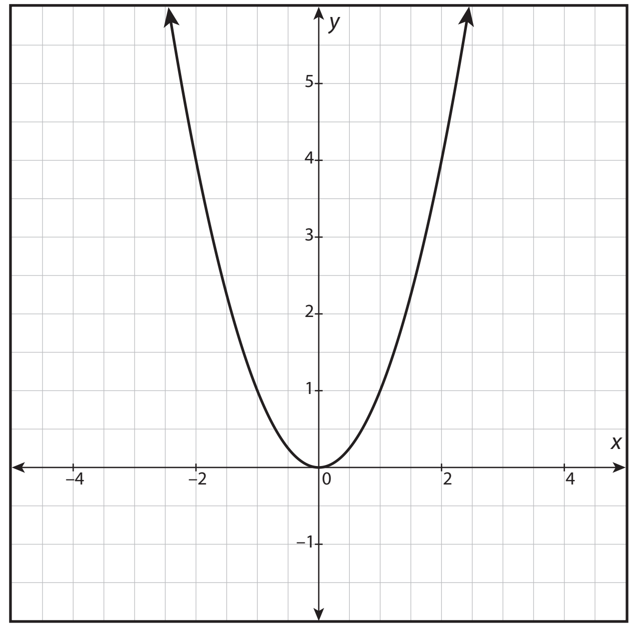
4. y-intercept: 3; vertex: (2, –1); the vertex is a minimum because $a > 0$.
5. y-intercept: 0; vertex: (3, –9); it has a minimum because $a > 0$.
6. y-intercept: –6; vertex: (–1, 1); it has a maximum because $a < 0$.
7. Yes, the y-intercept is –28 and the graph opens up because $a > 0$.
8. $y = -x^2 - 6x - 2$
9. 328 feet
10. $36.67

Practice 3.2.1 B: Creating and Graphing Equations Using Standard Form, p. U3-174

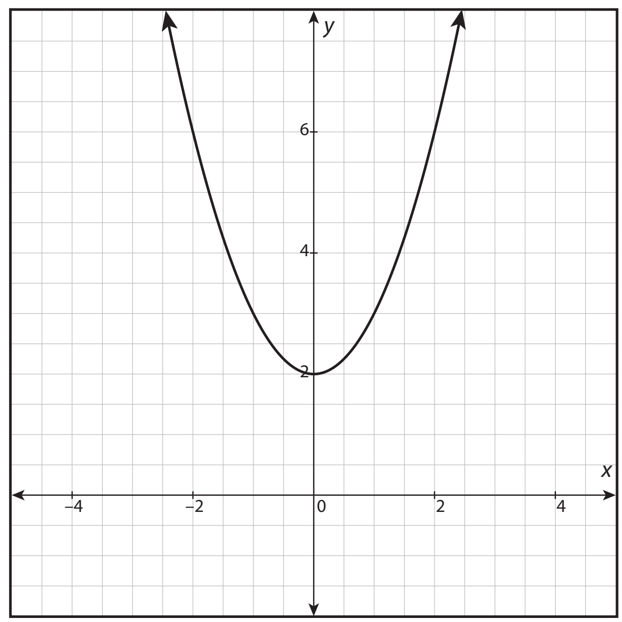
1.



2.

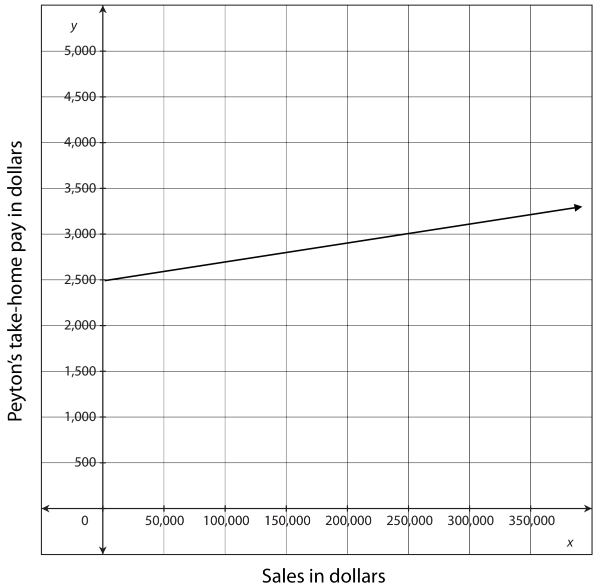


3.



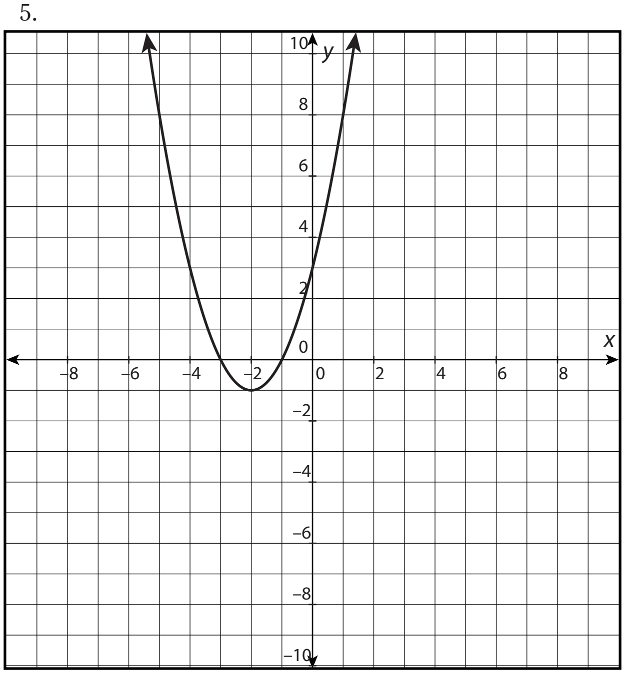
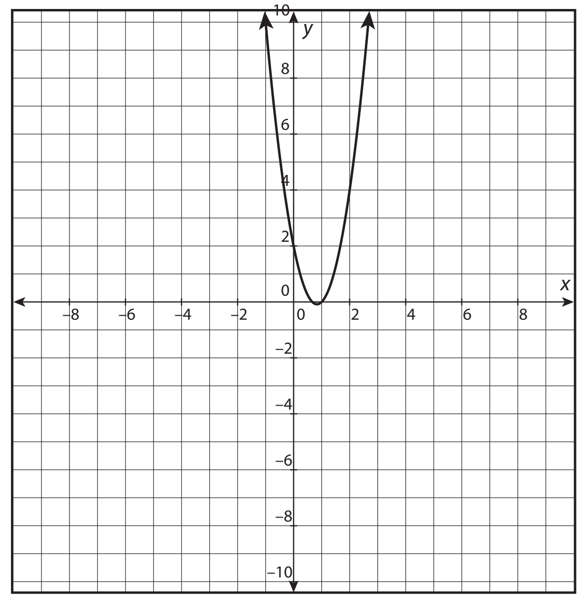
4. y-intercept: 0; vertex: (–1.75, 6.125); the vertex is a maximum because $a < 0$.
5. y-intercept: 7; vertex: (–5, –93); the vertex is a minimum because $a > 0$.
6. y-intercept: 3; vertex: (1, 5); the vertex is a maximum because $a < 0$.
7. No. The y-intercept is –5 because the constant term is –5. However, the graph shows a y-intercept of –10.
8. $y = -3x^2 + 30x - 69$
9. approximately 356 feet
10. 5,000 pairs of socks

Warm-Up 3.2.2, p. U3-176

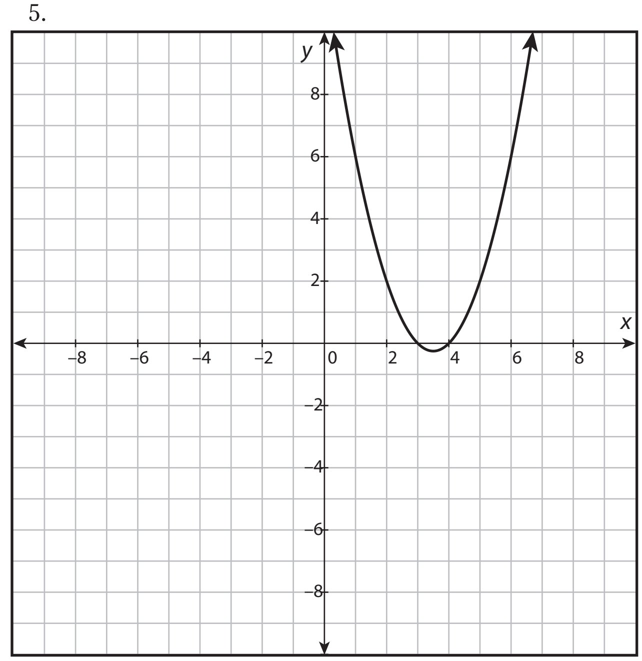
1. $y = 0.002x + 2500$
2. 

3. *x*-intercept: –1,250,000; *y*-intercept: 2,500
4. The *x*-intercept is the total amount of monthly car sales when Peyton has made $0 in a month. This is impossible since she has a fixed monthly salary of $2,500. The *y*-intercept is the total monthly take-home pay when Peyton sells 0 cars.

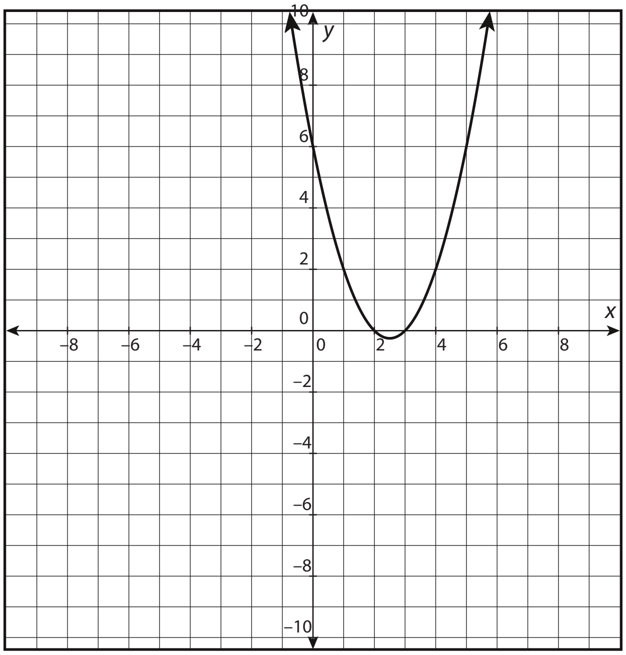
Practice 3.2.2 A: Creating and Graphing Equations Using the *x*-intercepts, p. U3-191

1. *x*-intercepts: 3, –6; axis of symmetry: $x = -1.5$
2. *x*-intercepts: 2/3, –2/3; axis of symmetry: $x = 0$
3. $y = 0.4x^2 + 1.6x + 1.6$
4. $y = x^2 + 7x - 60$
5. 
6. 
7. $y = -2x^2 + 8$
8. $y = x^2 - 36$
9. 5 inches by 7 inches
10. 25 seconds

Practice 3.2.2 B: Creating and Graphing Equations Using the *x*-intercepts, p. U3-193

1. *x*-intercepts: 1/16, 7; axis of symmetry: $x = 3.53$
2. *x*-intercepts: 3/4, –7/2; axis of symmetry: $x = -1.375$
3. $y = x^2 + 6x + 8$
4. $y = x^2 - 20x + 75$
5. 

6.



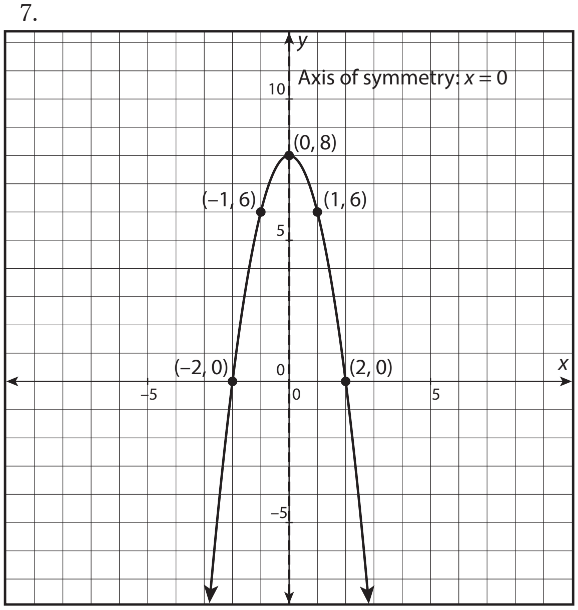
7. $y = 3x^2 + 15x - 18$
8. $y = 5x^2 - 30x + 40$
9. 8 feet
10. 1.25 seconds

Warm-Up 3.2.3, p. U3-196

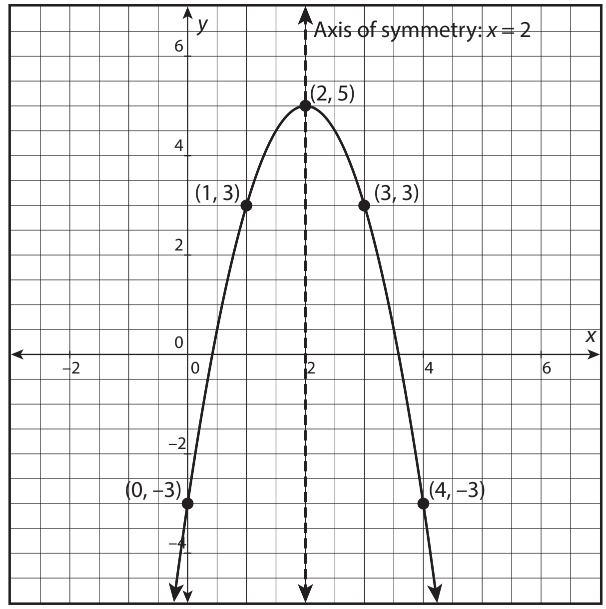
1. \$3.25
2. \$5,070

Practice 3.2.3 A: Creating and Graphing Equations Using Vertex Form, p. U3-209

1. Vertex: (–3, –3); it is a maximum because $a < 0$.
2. Vertex: (6, 6); it is a minimum because $a > 0$.
3. $y = 0.89(x + 2.50)^2 - 3$ or $y = \frac{8}{9}\left(x + \frac{5}{2}\right)^2 - 3$
4. $y = -2(x - 2)^2 + 10$
5. $f(x) = (x + 3)^2$
6. $g(x) = 3(x - 2)^2 - 3$
7.



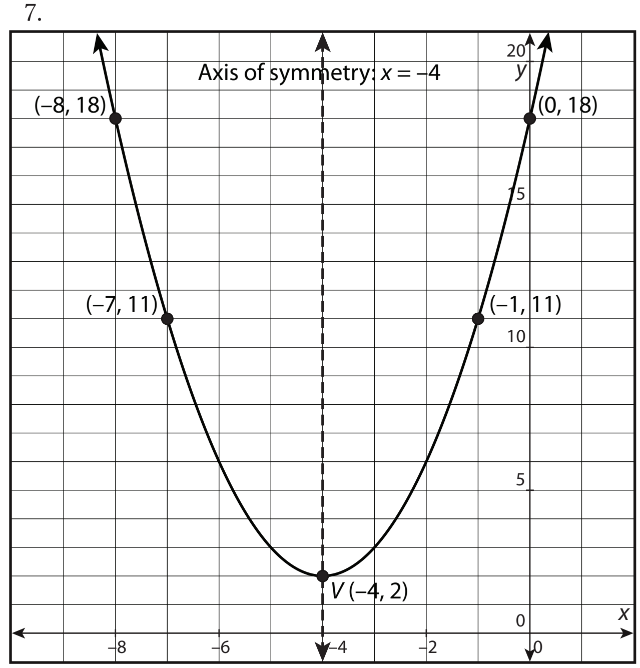
8.



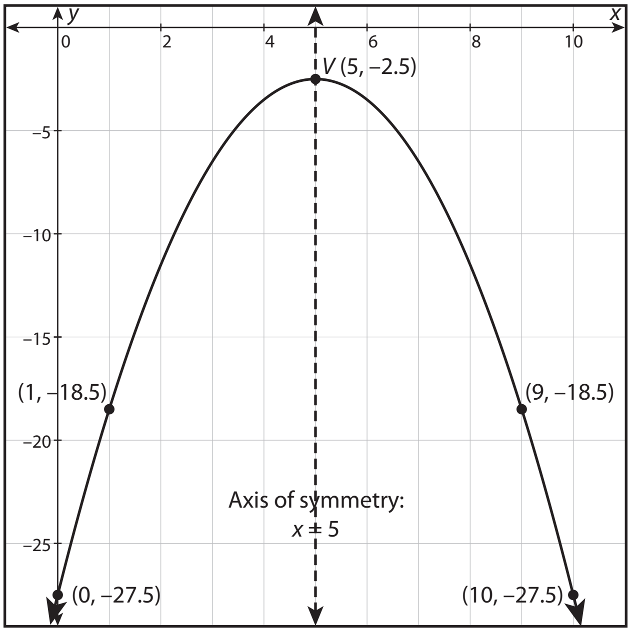
9. $y = -\frac{25}{144}(x - 24)^2 + 100$
10. $y = -2(x - 3)^2 + 18$

Practice 3.2.3 B: Creating and Graphing Equations Using Vertex Form, p. U3-210

1. Vertex: (–4, 1); it is a maximum because $a < 0$.
2. Vertex: (2, 0); it is a minimum because $a > 0$.
3. $y = 0.96(x - 5.5)^2 - 6$
4. $y = 5(x - 2)^2$
5. $f(x) = (x - 1)^2 - 3$
6. $g(x) = 0.3(x + 2)^2$
7.



8.



9. $y = -2(x - 6)^2 + 72$
10. $y = -3.49(x - 10.5)^2 + 385$

Warm-Up 3.2.4, p. U3-211

1. Rearrange the formula so that *h* is isolated.
2. $h = \dfrac{2A}{b_1 + b_2}$
3. The wall is 30 feet tall.

Practice 3.2.4 A: Rearranging Formulas Revisited, p. U3-223

1. $x = \pm\sqrt{25 - y^2}$
2. $x = -3 \pm \sqrt{y}$
3. $x = -7 \pm \dfrac{7y}{4}$
4. $x = -1 \pm \sqrt{\dfrac{y+90}{2}}$
5. $r = \sqrt{\dfrac{3V}{\pi h}}$
6. $r = \sqrt{\dfrac{A}{\pi}}$
7. $b = \sqrt{c^2 - a^2}$
8. $v = \sqrt{\dfrac{2E_k}{m}}$
9. $x = h \pm \sqrt{\dfrac{y-k}{a}}$
10. $b = \sqrt{\dfrac{a^2(y-k)^2}{a^2 - (x-h)^2}}$

Practice 3.2.4 B: Rearranging Formulas Revisited, p. U3-224

1. $x = \pm\sqrt{360 - 4y^2}$
2. $x = \pm\sqrt{\dfrac{y+9}{16}}$
3. $x = -7 \pm \sqrt{\dfrac{y}{4}}$
4. $x = 6.5 \pm \sqrt{\dfrac{y+20}{2.5}}$
5. $V = \pm\sqrt{PR}$
6. $r = \sqrt{\dfrac{2A}{\theta}}$
7. $c = \sqrt{a^2 + b^2}$
8. $v = \sqrt{ar}$
9. $y = k \pm \sqrt{r^2 - (x-h)^2}$
10. $r = \sqrt{\dfrac{SA}{4\pi}}$

Progress Assessment, p. U3-226

1. a
2. c
3. b
4. c
5. a
6. b
7. c
8. c
9. a
10. b
11. a. vertex: (1.5, –5); axis of symmetry: $x = 1.5$
    b. $y = 4x^2 - 12x + 4$
    c. *x*-intercepts: 0.38 and 2.62. These represent how much time has elapsed from the start of the pelican's descent, indicating when the pelican enters and exits the water, respectively.

Lesson 3: Interpreting and Analyzing Quadratic Functions

Pre-Assessment, p. U3-229

1. a
2. b
3. c
4. a
5. c

Warm-Up 3.3.1, p. U3-234

1. The *x*-intercepts are 0 and 8.
2. The equation for the axis of symmetry is $x = 4$. It is midway between the *x*-intercepts.
3. The vertex is (4, 6).
4. Yes, it will. Sketch the boulder's path using (0, 0), (4, 6), and (8, 0); the path is above the obstacle.
5. No, it will not. If you substitute $x = 7$ into the equation of the parabola, you find that the *y*-value of the boulder is slightly above the boxes.

Practice 3.3.1 A: Interpreting Key Features of Quadratic Functions, p. U3-254

1. $x > 0.3$, $x < 0.3$; minimum = –5.3; *x*-intercepts: –1 and 1.67; *y*-intercept: –5; neither
2. $x < 1.667$, $x > 1.667$; maximum = 9.333; *x*-intercepts: –0.097 and 3.431; *y*-intercept: 1; neither
3. $x > -1$, $x < -1$; minimum = 6; no *x*-intercepts; *y*-intercept: 11; neither
4. $x > 1$, $x < 1$; minimum = –13; *x*-intercepts: –1.55 and 3.55; *y*-intercept: –11; neither
5. $x = -0.67$; $x > -0.67$, $x < -0.67$
6. $x = 1.125$; $x < 1.125$, $x > 1.125$
7. $x = 0.375$; $x > 0.375$, $x < 0.375$
8. $x = 0.15$; $x > 0.15$, $x < 0.15$
9. The height of the softball increases until it reaches a distance of 25 feet, and then it decreases.
10. The maximum temperature is about 62.5˚.

Practice 3.3.1 B: Interpreting Key Features of Quadratic Functions, p. U3-256

1. $x > 1.5$, $x < 1.5$; minimum = –8.25; *x*-intercepts: –1.37 and 4.37; *y*-intercept: –6; neither
2. $x < -2$, $x > -2$; maximum = 11; *x*-intercepts: –5.32 and 1.32; *y*-intercept: 7; neither

3. $x < 1$, $x > 1$; maximum = 16; x-intercepts: –1 and 3; y-intercept: 12; neither
4. $x > 0$, $x < 0$; minimum = 0; x-intercept: 0; y-intercept: 0; even
5. $x = -16.3$; $x > -16.3$, $x < -16.3$
6. $x = 2.25$; $x > 2.25$, $x < 2.25$
7. $x = -0.5$; $x < -0.5$, $x > -0.5$
8. $x = -0.02$; $x > -0.02$, $x < -0.02$
9. The height of the football is increasing for the first second and then it is decreasing.
10. The flare will explode at 256 feet.

Warm-Up 3.3.2, p. U3-258

1. $y = 3x + 64$
2. all whole numbers
3. The domain represents the possible number of games that Gina could sell in one 8-hour workday.

Practice 3.3.2 A: Identifying the Domain and Range of a Quadratic Function, p. U3-269

1. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers greater than or equal to 13.25, or $-\infty < y \le 13.25$
2. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers up to 180.75, or $-\infty < y \le 180.75$
3. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers up to about 13.6, or $-\infty < f(x) \le 13.6$
4. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers greater than or equal to –44, or $-44 \le g(x) < \infty$
5. Domain: all real numbers; $-\infty < x < \infty$; range: all real numbers up to about 5.3, or $-\infty < y \le 5.3$
6. Domain: all real numbers; $-\infty < x < \infty$; range: all real numbers greater than or equal to –9.6, or $-9.6 \le y < \infty$
7. Domain: all real numbers; $-\infty < x < \infty$; range: all real numbers up to about 4.1, or $-\infty < y \le 4.1$
8. less than 3.9 seconds
9. 9.4 seconds
10. Domain: $8.67 \le x \le 28.83$; range: $0 \le P(x) \le 1625$; $x = \$18.75$

Practice 3.3.2 B: Identifying the Domain and Range of a Quadratic Function, p. U3-272

1. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers greater than or equal to about 0.7, or $0.7 \le y < \infty$
2. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers up to about 141.3, or $-\infty < y \le 141.3$
3. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers greater than or equal to about –4.4, or $-4.4 \le f(x) < \infty$
4. Domain: all real numbers or $-\infty < x < \infty$; range: all real numbers greater than or equal to –27, or $-27 \le g(x) < \infty$
5. Domain: all real numbers; $-\infty < x < \infty$; range: all real numbers up to about 16.25, or $-\infty < y \le 16.25$
6. Domain: all real numbers; $-\infty < x < \infty$; range: all real numbers greater than or equal to –15, or $-15 \le y < \infty$
7. Domain: all real numbers; $-\infty < x < \infty$; range: all real numbers greater than or equal to –10, or $-10 \le y < \infty$
8. less than 10 seconds
9. about 3 seconds
10. 25 increases; 5.5 increases

Warm-Up 3.3.3, p. U3-275

1. –1/2
2. $G(x) = (-1/2)x + 65$
3. The car's mileage will always be reduced by 1 mile per gallon for every 2 miles per hour the speed of the car increases.

Practice 3.3.3 A: Identifying the Average Rate of Change, p. U3-288

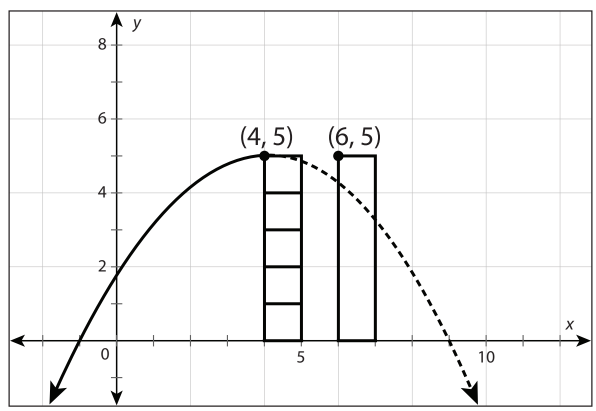
1. 4
2. 6
3. –4
4. 0
5. –12
6. 7
7. between $x = 0$ and $x = 2$
8. between $x = -2$ and $x = 0$
9. between $x = 0$ and $x = 2$
10. –80 ft/s

Practice 3.3.3 B: Identifying the Average Rate of Change, p. U3-290

1. –16
2. 8
3. –3/2
4. –18
5. –26
6. 2
7. between $x = -1$ and $x = 0$
8. between $x = -2$ and $x = -1$
9. between $x = -1$ and $x = 0$
10. –56 ft/s

Warm-Up 3.3.4, p. U3-292

1. The vertex is (4, 5).
2. The second x-intercept is 9.
3. The maximum is 5.
4.

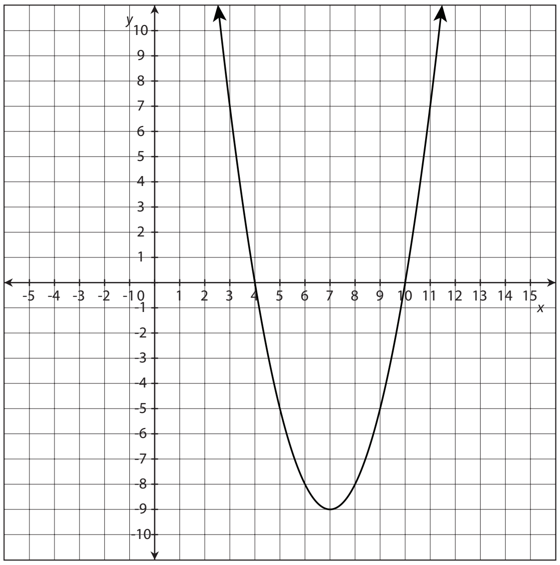


5. No, the water will not clear the boxes. If the boxes were not in the way, the water would still not fill the birdbath because the birdbath is too tall.

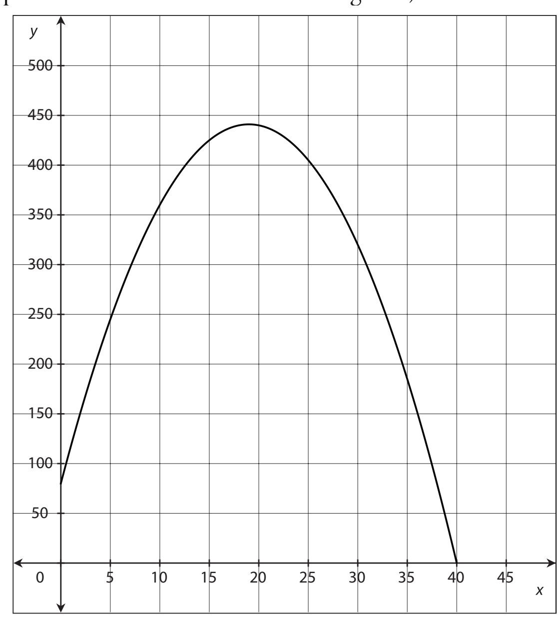
Practice 3.3.4 A: Writing Equivalent Forms of Quadratic Functions, p. U3-311

1. a. 8
   b. (3, –1)
   c. minimum
2. a. –2 and 4
   b. 4
   c. $x = 1$
   d. (1, 4.5)

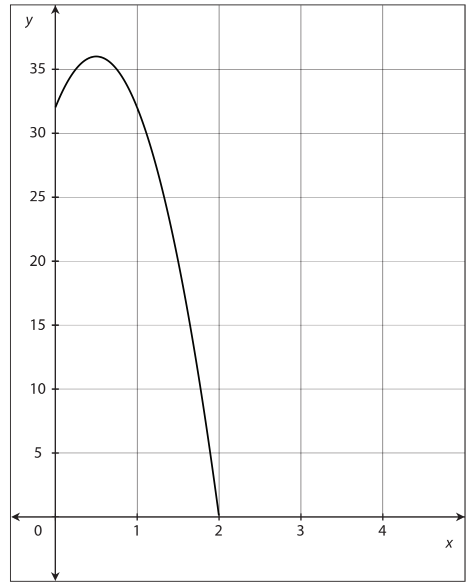
3. a. (1, 10)
   b. maximum
4. (7, –9); after the bird travels for 7 seconds, it reaches its minimum height, which is 9 feet below the surface of the water.



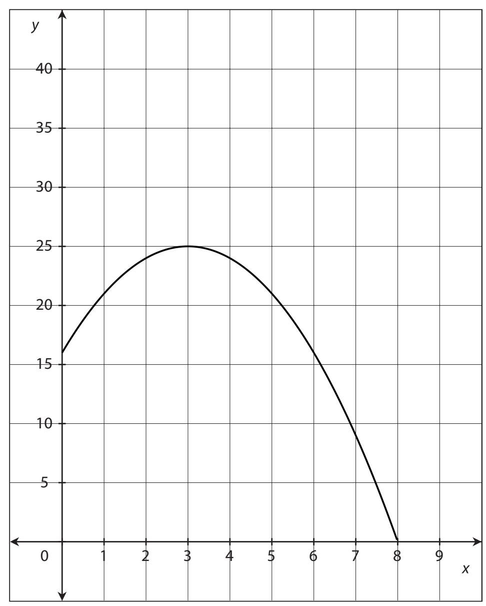
5. –2 and 40; the *x*-intercepts represent the times when the height is 0 miles, which is when the missile is on the ground. The *x*-intercept of –2 does not make sense in the problem because time cannot be negative; 38 seconds.



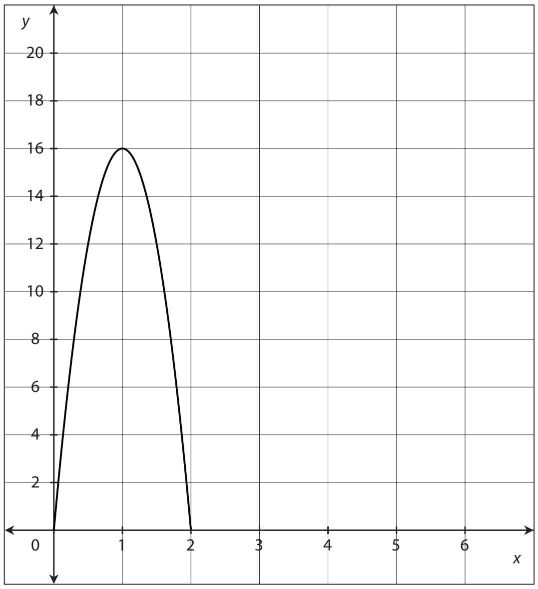
6. –1 and 2; the *x*-intercepts represent the times when the snowboarder is on the ground. The *x*-intercept –1 does not make sense because time cannot be negative; 2 seconds.



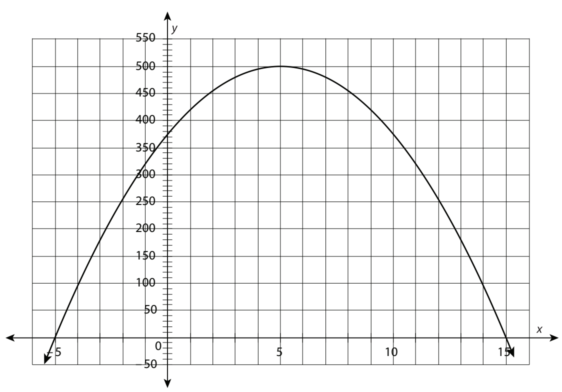
7. (3, 25); the paper airplane will reach a maximum height of 25 feet after traveling 3 feet in the horizontal direction.



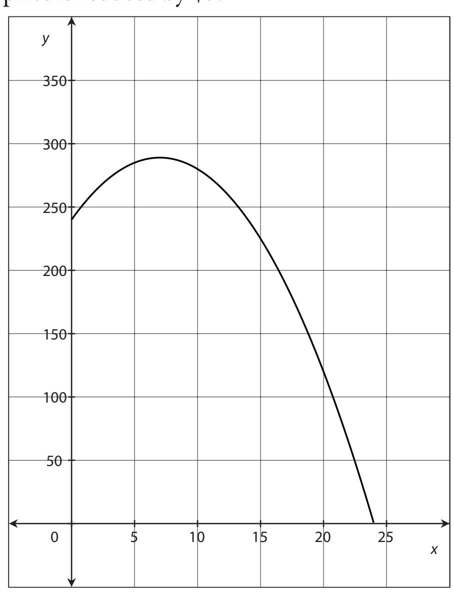
8. (1, 16); the golf ball will reach a maximum height of 16 feet 1 second after being hit.



9. –5 and 15; the *x*-intercepts represent the number of dollars in price increase/decrease that would result in no revenue; 5.

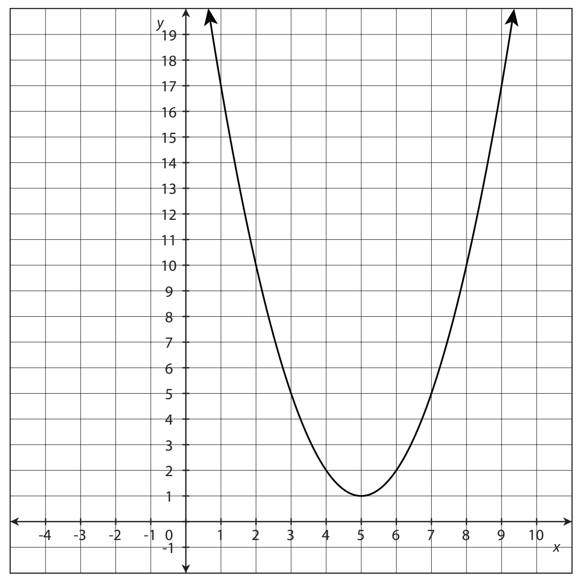


10. (7, 289): the maximum revenue of $289 will occur when the price is reduced by $7.

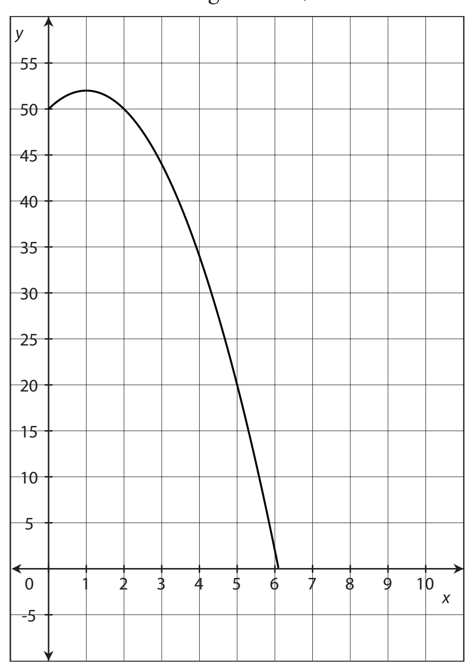


Practice 3.3.4 B: Writing Equivalent Forms of Quadratic Functions, p. U3-313

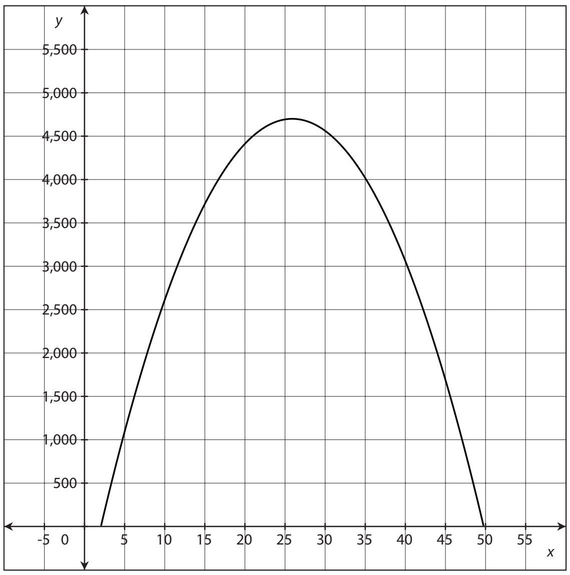
1. a. 12
   b. (4, –4)
   c. minimum
2. a. 3 and –5
   b. 30
   c. $x = -1$
   d. (–1, 32)
3. a. (3, 0)
   b. maximum
4. (5, 1); the butterfly reaches its minimum height of 1 foot above the ground 5 seconds after you see it.



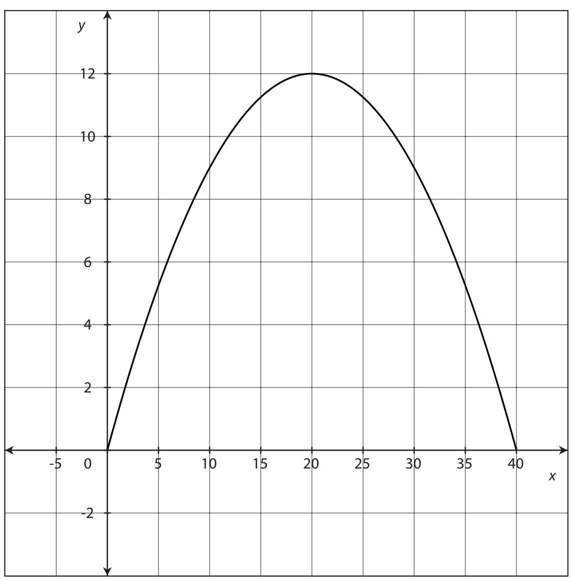
5. (1, 52); the cliff diver reaches a maximum height of 52 feet 1 second after starting the dive; 2 seconds



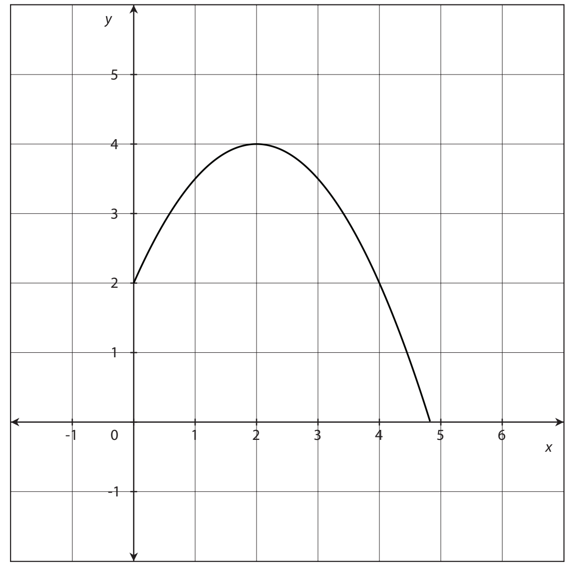
6. 2 and 50; the *x*-intercepts represent the number of widgets sold that result in no revenue; 26 widgets



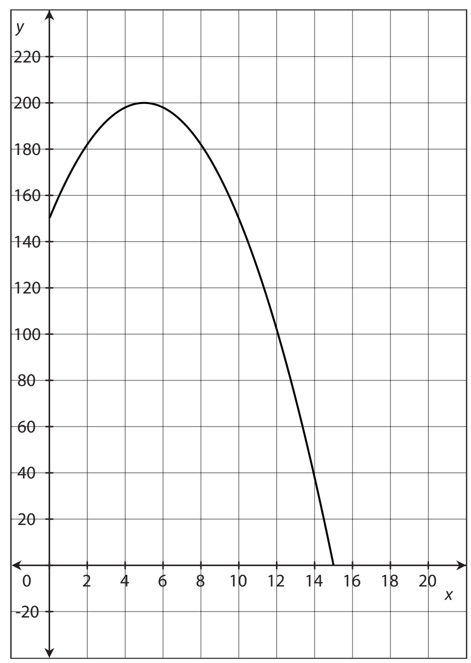
7. (20, 12); the football reaches a maximum height of 12 feet after it has traveled 20 feet in the horizontal direction; 40 feet



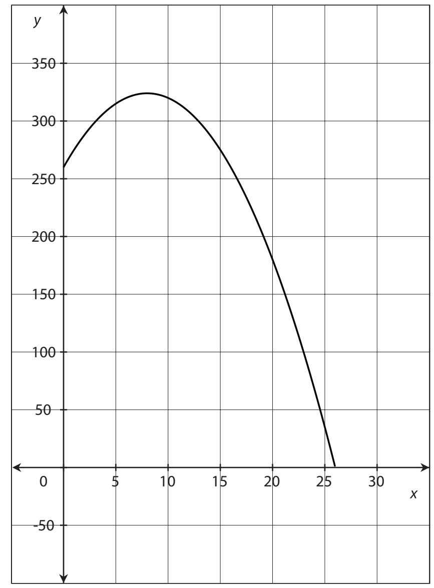
8. (2, 4); the frog reaches its maximum height of 4 feet after 2 seconds; $x = 2$; 4 seconds



9. (5, 200); the revenue reaches its maximum value of $200 when the price is increased by $5; $x = 5$; $10



10. –10 and 26; the x-intercepts represent price decreases that result in no revenue. The x-intercept –10 does not make sense in the context of the problem because a price decrease should not be negative; $x = 8$; \$16



Progress Assessment, p. U3-315

1. b
2. c
3. c
4. d
5. d
6. b
7. b
8. c
9. c
10. a
11. a. –1.2 mpg
    b. values of s between 48 and 70 mph
    c. $G(s) = 33$ mpg, at $s = 48$ mph

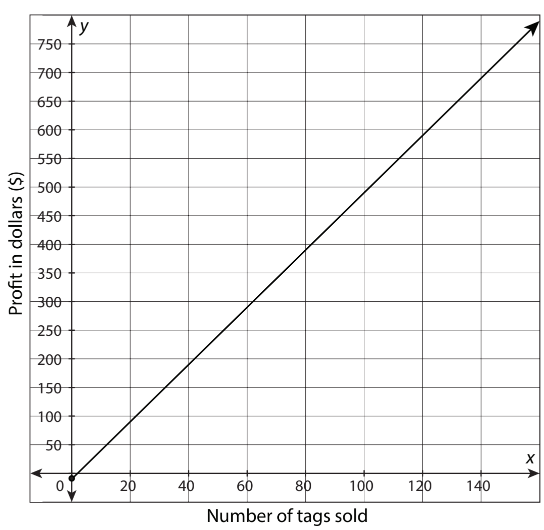
Lesson 4: Transforming Functions

Pre-Assessment, p. U3-318

1. a
2. d
3. b
4. a
5. c

Warm-Up 3.4.1, p. U3-322

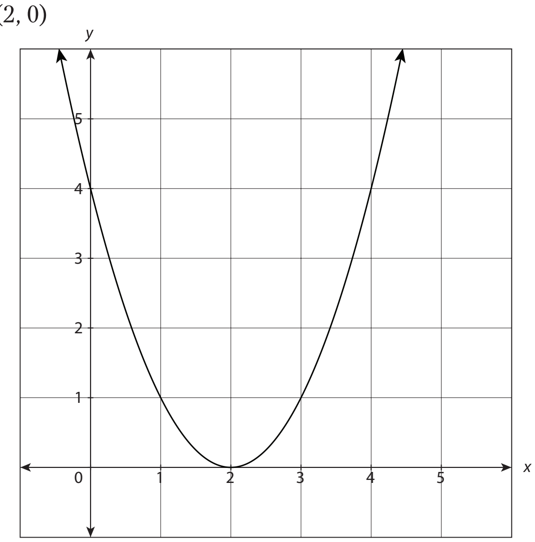
1. $f(x) = 5x - 10$
2.



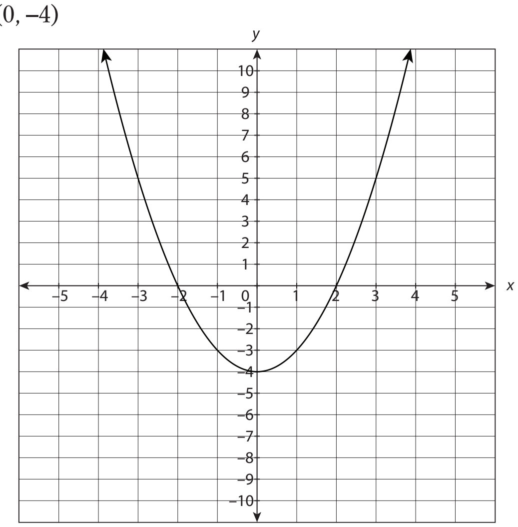
3. The revenues would increase by \$2. This would affect the y-intercept, and the graph would move up 2 units.

Practice 3.4.1 A: Replacing $f(x)$ with $f(x) + k$ and $f(x + k)$, p. U3-339

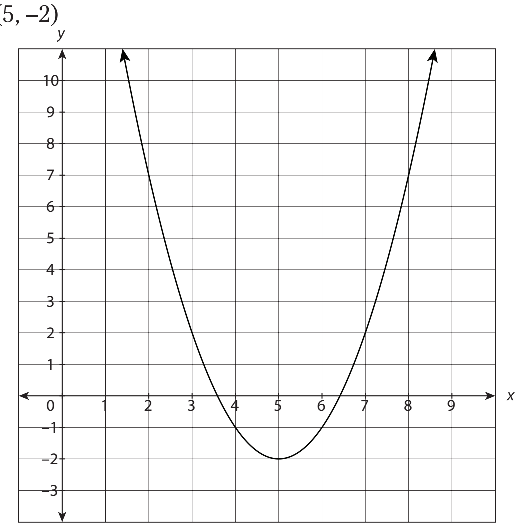
1. $y = (x + 2)^2$
2. $y = x^2 + 3$
3. $y = (x - 5)^2 - 2$
4. (2, 0)



5. (0, –4)



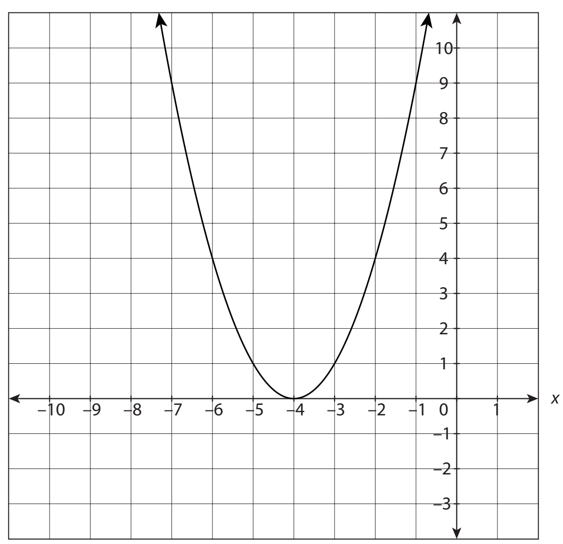
6. (5, –2)



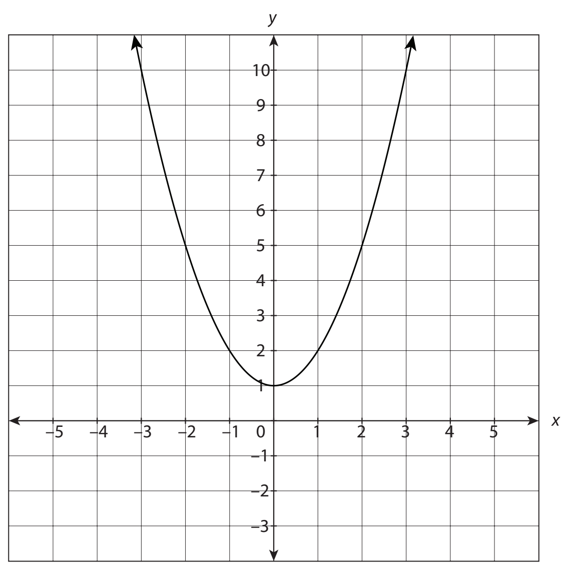
7. $y = -(x + 4)^2$; $k = 4$
8. $f(x) = -0.0009(x - 18)^2 + 0.2088(x - 18)$
9. $f(x) = -0.03x^2 + 1.3x + 16$; the ball will land about 53 feet away.
10. $f(x) = -\frac{1}{8}(x - 13)^2 + 10$; yes, it will land in the basket.

Practice 3.4.1 B: Replacing *f*(*x*) with *f*(*x*) + *k* and *f*(*x* + *k*), p. U3-341

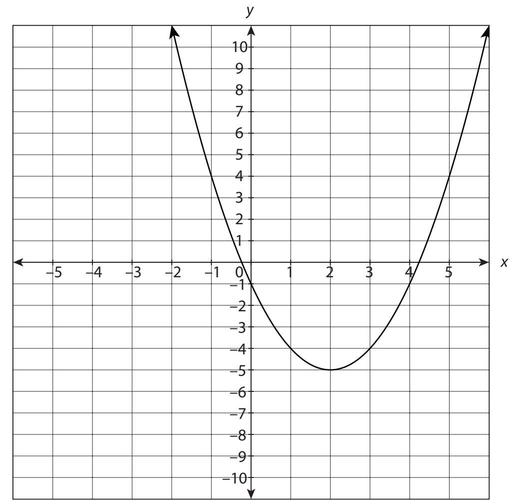
1. $y = (x - 3)^2$
2. $y = x^2 - 4$
3. $y = (x + 6)^2 - 1$
4.



5.



6.



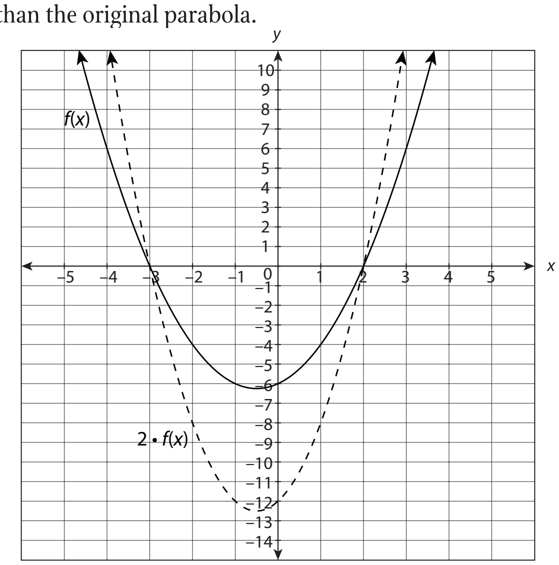
7. $y = -(x + 2)^2 + 5$. For the horizontal translation, $k = 2$. For the vertical translation, $k = 5$.
8. $f(x) = -0.0008(x - 12)^2 + 0.24(x - 12)$
9. $f(x) = -0.05x^2 + x + 19$; the paper wad will land about 32 feet away.
10. $f(x) = -0.4\,(x - 9)^2 + 14$; yes, it will hit the target.

Warm-Up 3.4.2, p. U3-343

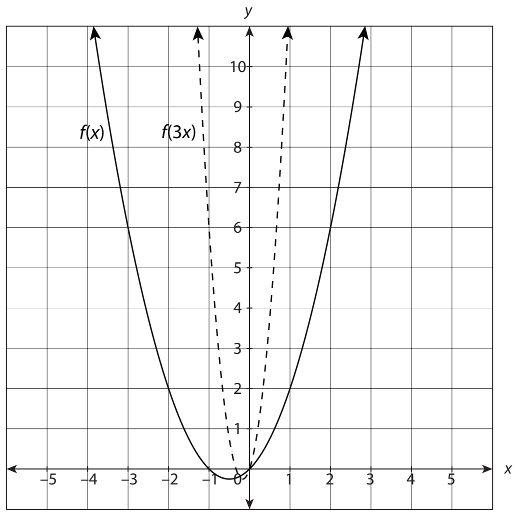
1. 576 ft^2
2. 1,728 ft^2
3. 1,936 ft^2

Practice 3.4.2 A: Replacing *f*(*x*) with *k* • *f*(*x*) and *f*(*k* • *x*), p. U3-363

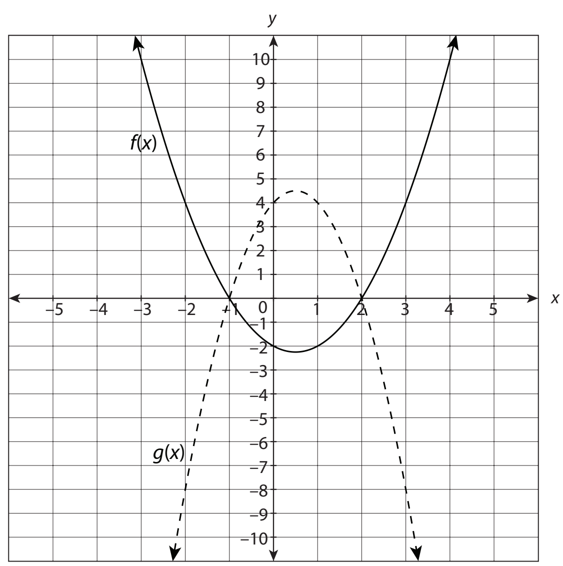
1. $2 \bullet f(x) = 2x^2 + 2x - 12$. Since the entire function is being multiplied by 2, the *x*-intercepts of the two functions are the same. However, the second parabola, $2 \bullet f(x)$, is stretched vertically because each *y*-coordinate has been multiplied by 2. As a result, the new parabola is narrower than the original parabola.



2. $f(3x) = 9x^2 + 3x$. Since the variable x is multiplied by 3, the graph is compressed horizontally by a factor of $\frac{1}{3}$. That is, each x-value is multiplied by $\frac{1}{3}$, so the width of the parabola becomes narrower. The y-intercept remains the same, as do the minimum values of the functions. The x-intercepts change and the interval between them becomes narrower.

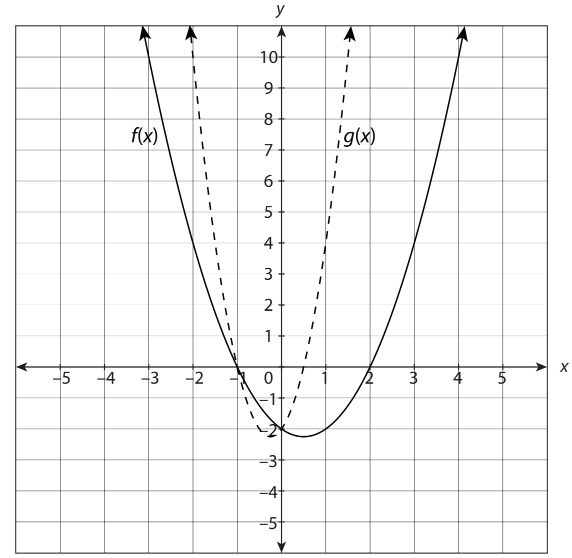


3. Answers may vary. Apply the transformation $k \bullet f(x)$, where $0 < k < 1$. Sample answer: $1/2 \bullet f(x) = g(x) = 0.5x^2 - 0.5x - 1$
4. Answers may vary. Apply the transformation $f(k \bullet x)$, where $k > 1$. Sample answer: $f(2x) = g(x) = 4x^2 + 6x - 4$
5. Graph of $f(x)$ and $g(x)$:



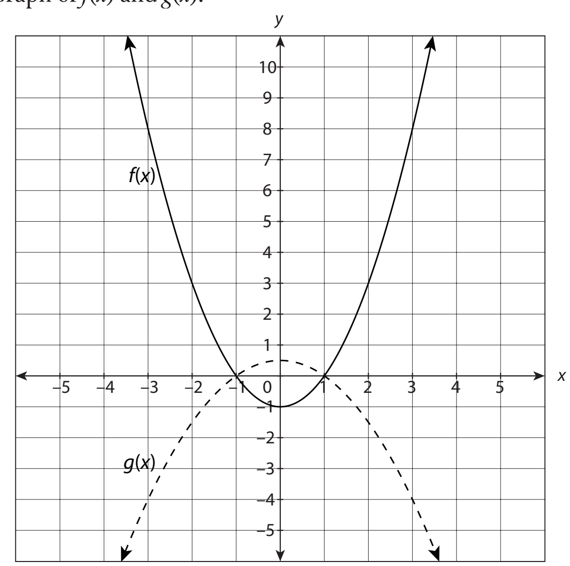
Since $g(x)$ is a multiple of $f(x)$, it will have the same x-intercepts as $f(x)$: –1 and 2. Since the value of k is –2, the graph will be stretched vertically by a factor of 2, and it will reflect over the x-axis because $k < 0$.

6. Graph of $f(x)$ and $g(x)$:



The function $g(x)$ is obtained by multiplying the x-values in $f(x)$ by –2. This means that the y-intercept will be the same, the minimum y-value will be the same, but the x-intercept will change and the interval becomes narrower. The graph of $g(x)$ will be compressed horizontally by a scale factor of 1/2, and the graph will be reflected over the y-axis.

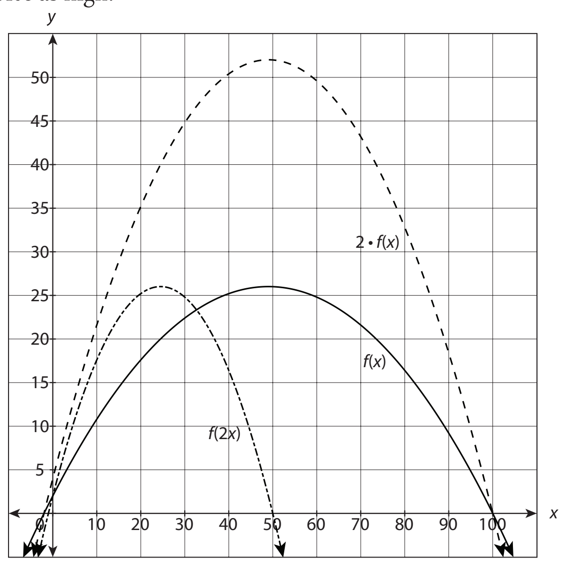
7. Graph of $f(x)$ and $g(x)$:



Since $g(x)$ is a multiple of $f(x)$, it will have the same x-intercepts as $f(x)$: –1 and 1. Since the value of k is $-\frac{1}{2}$, the graph will be compressed vertically by a factor of $\frac{1}{2}$, and it will reflect over the x-axis because $k < 0$.

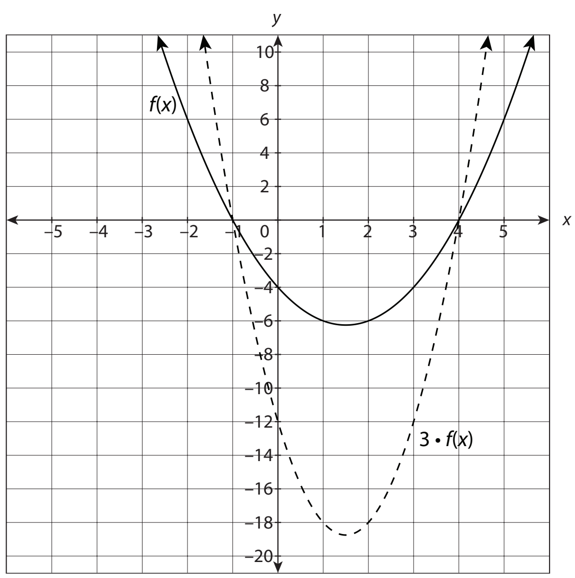
8. If the sides of the original pen were doubled, then the side lengths would be $2x$ and $4x$. The area would be $f(2x) = 2(2x)^2 = 8x^2$. If the farmer were to build a second pen of the same size, the area of the two pens would be $2 \bullet f(x) = 2(2x^2) = 4x^2$. Doubling the side length gives a larger area.

9. $f(x)$ represents the profit, so a doubling of the profit is modeled by $2 \bullet f(x)$.
10. Neither player is correct because neither of the equations leads to a ball going farther than the original ball. Jada's equation, $f(2x) = -0.01(2x)^2 + 0.98(2x) + 2$, leads to a ball going the same height as the original ball but only half as far; Jayla's equation, $2 \bullet f(x) = 2(-0.01x^2 + 0.98x + 2)$, leads to a ball going the same distance as the original ball but twice as high.

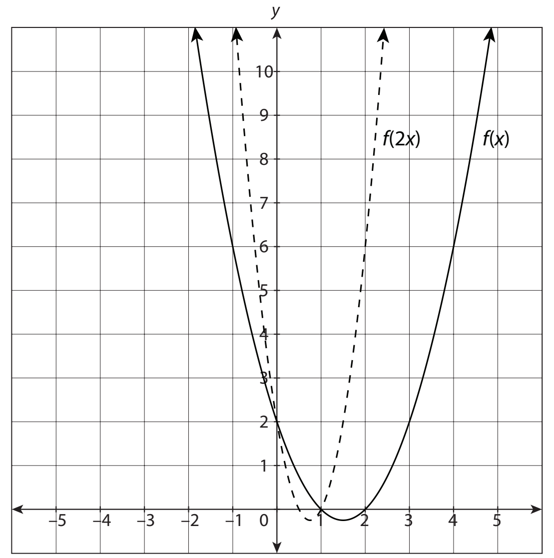


Practice 3.4.2 B: Replacing $f(x)$ with $k \bullet f(x)$ and $f(k \bullet x)$, p. U3-366

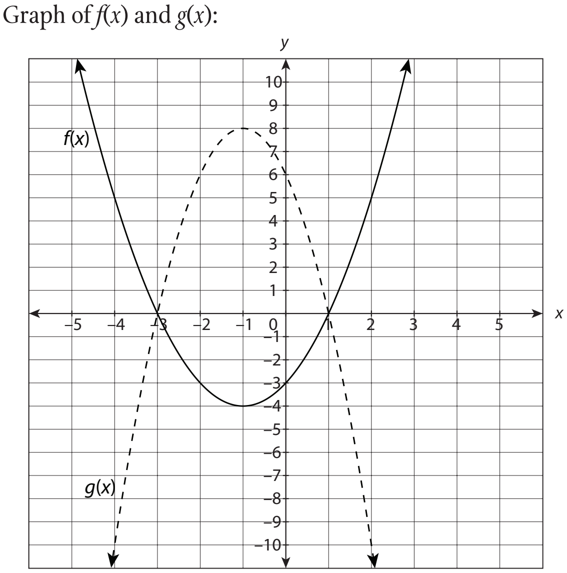
1. $3 \bullet f(x) = 3x^2 - 9x - 12$. Since the entire function is being multiplied by 3, the x-intercepts of the two functions are the same (–1 and 4). However, the second parabola, $3 \bullet f(x)$, is stretched vertically because each y-coordinate is multiplied by 3. As a result, the new parabola is narrower than the original parabola.



2. $f(2x) = 4x^2 - 6x + 2$. Since the variable x is multiplied by 2, the graph shrinks horizontally by a factor of $\frac{1}{2}$. That is, each x-value is multiplied by $\frac{1}{2}$, so the width of the parabola becomes narrower. The y-intercepts remain the same, as do the minimum values of the functions. The x-intercepts change and the interval becomes narrower.

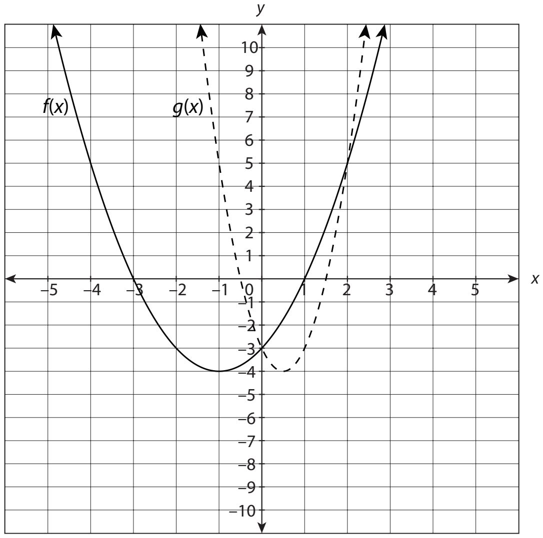


3. Answers may vary. Apply the transformation $k \bullet f(x)$, where $k > 1$. Sample answer: $2 \bullet f(x) = g(x) = 2x^2 - 8x + 6$
4. Answers may vary. Apply the transformation $f(k \bullet x)$, where $k > 1$. Sample answer: $f(2x) = g(x) = 4x^2 - 2x - 1$
5. Graph of $f(x)$ and $g(x)$:



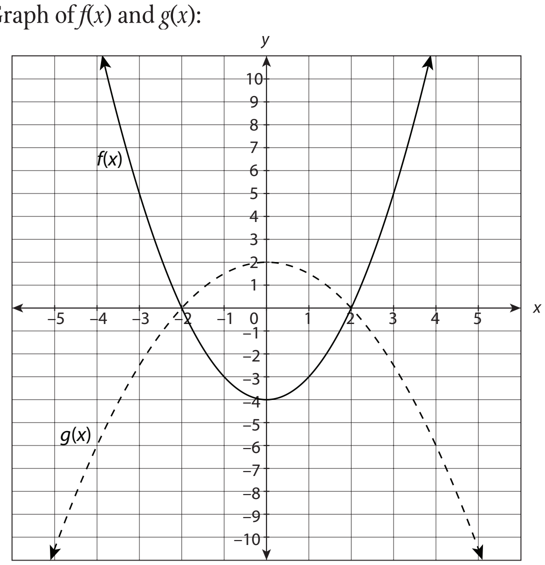
Since $g(x)$ is a multiple of $f(x)$, it will have the same x-intercepts as $f(x)$: –3 and 1. Since the value of k is –2, the graph will be stretched vertically by a factor of 2, and it will reflect over the x-axis because $k < 0$.

6. Graph of $f(x)$ and $g(x)$:



The function $g(x)$ is obtained by multiplying the x-values in $f(x)$ by –2. This means that the y-intercept will be the same, the minimum y-value will be the same, the x-intercepts will change and the interval between them will become narrower. The graph of $g(x)$ will be compressed horizontally by a factor of 1/2, and the graph will be reflected over the y-axis.

7. Graph of $f(x)$ and $g(x)$:

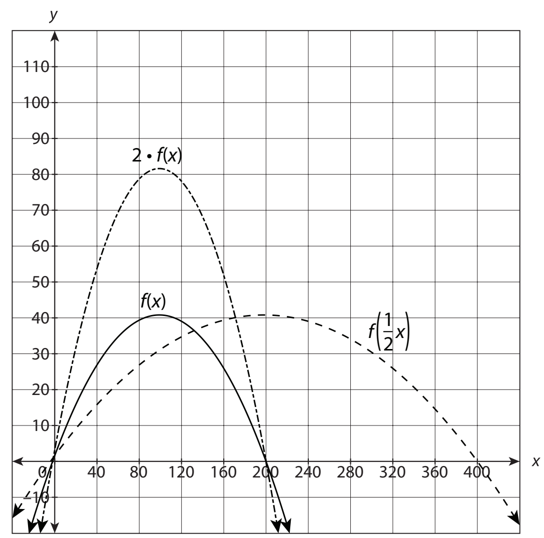


Since $g(x)$ is a multiple of $f(x)$, it will have the same x-intercepts as $f(x)$: –2 and 2. Since the value of k is $-\frac{1}{2}$, the graph will be condensed vertically by a factor of $\frac{1}{2}$, and it will reflect over the x-axis because $k < 0$.

8. The original closet has side lengths of x and $3x$. Let the area of the original closet be $f(x) = 3x^2$. If the sides of the original closet were tripled, then the side lengths would be $3x$ and $9x$. The area would be $f(3x) = 3(3x)^2 = 27x^2$. If the celebrity builds two additional closets of the same size, the area of the three closets would be $3 \bullet f(x) = 3(3x^2) = 9x^2$. Tripling the side length gives a larger area.

9. $f(x)$ represents the profit, so earning half of the profit is modeled by $\frac{1}{2} \bullet f(x)$.

10. Zion is correct because his equation, $f\left(\frac{1}{2}x\right)$, leads to a beanbag going twice as far as the original beanbag. This beanbag reaches the same height as the original beanbag. Zavier's equation, $2 \bullet f(x)$, leads to a beanbag going the same distance as the original beanbag but twice as high.



Progress Assessment, p. U3-369

1. b
2. b
3. a
4. a
5. d
6. d
7. b
8. b
9. c
10. b
11. a. $f(k \bullet x)$, where $0 < k < 1$ to stretch the parabola horizontally so that the path of the ball extends to reach the hoop.

    b. $k = \frac{19}{20}$

Lesson 5: Building and Comparing Quadratic Functions

Pre-Assessment, p. U3-374

1. b
2. c
3. d
4. a
5. c

Warm-Up 3.5.1, p. U3-378

1. 12 seconds
2. 13 seconds

Practice 3.5.1 A: Building Quadratic Functions From Context, p. U3-396

1. $f(x) = 2x^2 - 13x - 24$
2. $g(3) = 6$
3. $f(x) = x(x + 2)$; the integers are 60 and 62.
4. vertex: (2100, 20); y-intercept: (0, 500)
5. $f(x)=\frac{2}{18{,}375}(x-2100)^2+20$
6. vertex: (17, 16); y-intercept: (0, 6)
7. $f(x)=-\frac{10}{289}(x-17)^2+16$
8. $f(x)=\frac{1}{2}\text{ base} \bullet \text{height}=\frac{1}{2}x(16-x)$
9. 32 ft^2
10. 8 feet for both

Practice 3.5.1 B: Building Quadratic Functions From Context, p. U3-398

1. $f(x) = 10x^2 + 26x + 12$
2. $g(10) = 158$
3. $f(x) = x(x + 1)$; the integers are 91 and 92.
4. vertex: (800, 40); y-intercept: (0, 140)
5. $f(x)=\frac{1}{6400}(x-800)^2+40$
6. vertex: (23, 20); y-intercept: (0, 5)
7. $f(x)=-\frac{15}{529}(x-23)^2+20$
8. $f(x)=\text{ length} \bullet \text{width }=x\bullet\frac{1}{2}(32-x)=\frac{1}{2}x(32-x)$
9. 128 ft^2
10. The side parallel to the house should be 16 feet long, and the sides perpendicular to the house should each be 8 feet long.

Warm-Up 3.5.2, p. U3-400

1. the first bird
2. the second bird
3. the second bird

Practice 3.5.2 A: Comparing Properties of Quadratic Functions Given in Different Forms, p. U3-415

1. the function with $a > 0$
2. the function with no x-intercepts
3. the function with x-intercepts p and $-p$
4. No; the functions do not cross anywhere but the origin.
5. Model A has the shortest stopping distance at $x = 25$. It will always have the shortest stopping distance because the functions for the stopping distances do not cross anywhere but the origin.
6. Model B has the longest stopping distance at $x = 55$. It will always have the longest stopping distance because the functions for the stopping distances do not cross anywhere but the origin.
7. Type C
8. Type B
9. Type A: (2, 0)
Type B: (0, 0)
Type C: (4, 0)
10. Type A: (14, 0)
Type B: (16, 0)
Type C: (12, 0)

Practice 3.5.2 B: Comparing Properties of Quadratic Functions Given in Different Forms, p. U3-418

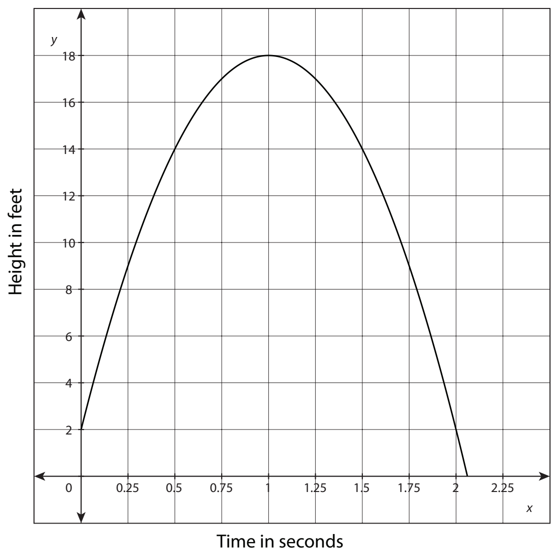
1. the function with no x-intercepts
2. the function with $a > 0$
3. the function with x-intercepts p and $-3p$
4. No; the functions do not cross anywhere but the origin.
5. Model B has the shortest stopping distance at $x = 25$. It will always have the shortest stopping distance because the functions for the stopping distances do not cross anywhere but the origin.
6. Model C has the longest stopping distance at $x = 55$. It will always have the longest stopping distance because the functions for the stopping distances do not cross anywhere but the origin.
7. Type B
8. Type C
9. Type A: (3, 0)
Type B: (5, 0)
Type C: (0, 0)
10. Type A: (13, 0)
Type B: (11, 0)
Type C: (16, 0)

Progress Assessment, p. U3-421

1. b
2. a
3. c
4. b
5. d
6. c
7. d
8. a
9. a
10. b
11. a. $Q(x)$ has a lower ideal sale price.
b. $P(x)$ predicts a higher maximum profit.

Unit Assessment
p. U3-426

1. c
2. a
3. d
4. d
5. c
6. b
7. b
8. c
9. a
10. d
11. d
12. b
13. a. The function is increasing when $x < 0$.
    b. The function is decreasing when $x > 0$.
    c. The vertex is (0, 144) and represents the maximum height of the crab, 144 feet, before it is dropped.
    d. A reasonable domain for this scenario is $0 \le x \le 3$ since the crab hits the rock at 3 seconds.
    e. The average rate of change is –56 feet/second.
14. a. The vertex is (1, 18) and represents the maximum height of the baseball, 18 feet, 1 second after it was hit.
    b. The equation that represents the axis of symmetry is $x = 1$.
    c.



15. a. $Q(x)$ has a higher ideal sale price.
    b. $P(x)$ predicts a higher maximum profit.
    c. The domain represents the set of possible sale prices, x, that yield a profit. While negative profit is possible, it is not desirable. Therefore, the domain will be values of x that give non-negative profit. The domain of $P(x)$ is $16 \le x \le 40$, and the domain of $Q(x)$ is $20 \le x \le 50$.
    d. The range represents the profit at various sale prices. While it is possible to have negative profit, it is not desirable. Therefore, the range of each will be the set of positive outputs. The range of $P(x)$ is $0 \le P(x) \le 5760$, and the range of $Q(x)$ is $0 \le Q(x) \le 4500$.