Answers

Chapter 1

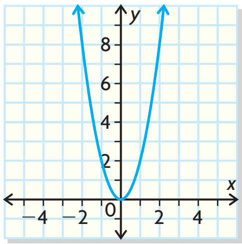
Getting Started, pp. 2–4

1. **a)** (ii) **b)** (v) **c)** (iv) **d)** (i) **e)** (vi) **f)** (iii)

2. **a)** -2 **b)** -1 **c)** -3 **d)** -12

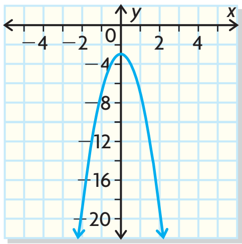
3. **a)**

x	y
-2	8
-1	2
0	0
1	2
2	8



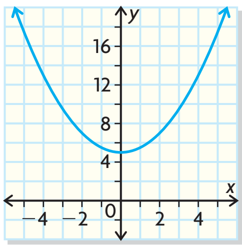
b)

x	y
-2	-19
-1	-7
0	-3
1	-7
2	-19



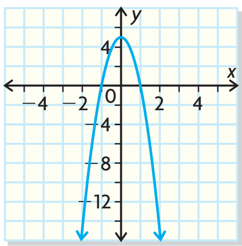
c)

x	y
-2	7
-1	5.5
0	5
1	5.5
2	7



d)

x	y
-2	-15
-1	0
0	5
1	0
2	-15



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

5. **a)** yes **b)** yes

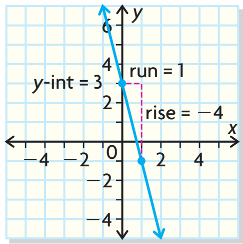
6. **a)** Yes. When I substitute 2 for x and -1 for y into $2x - y$, the equation $2x - y = 5$ is true.
b) No. When I substitute -1 for x and 29 for y, the equation $y = -2x^2 - 5x + 22$ is false.

7. **a)** $6; 4; -\frac{2}{3}$ **b)** $-8; 2; \frac{1}{4}$

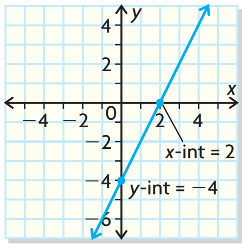
8. **a)** $2; x = 0$ **b)** $-4; x = 0$

9. **a)** B **b)** C **c)** D **d)** A

10. **a)**

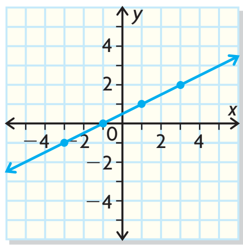


b)

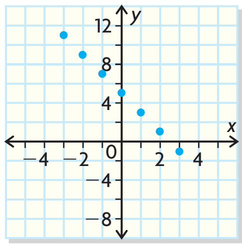


c)

x	y
-3	-1
-1	0
1	1
3	2



11. slope $= -2$, y-int $= 5$, equation: $y = -2x + 5$



12.

Definition:
A quadratic relations is a relation that can be described by an equation that contains a polynomial whose highest degree is 2.

Characteristics:
- axis of symmetry
- single maximum or minimum value

Quadratic Relation

Examples:
$y = x^2 + 7x + 10$
$y = x^2 - 8x + 7$

Non-examples:
$y = 4x + 3$
$y = x^3 - 1$

Lesson 1.1, pp. 13–16

1. a) i) D = {1, 3, 4, 7}, R = {2, 1}
ii) Function since there is only one y-value for each x-value.
b) i) D = {1, 4, 6}, R = {2, 3, 5, 1}
ii) Not a function since there are two y-values for $x = 1$.
c) i) D = {1, 0, 2, 3}, R = {0, 1, 3, 2}
ii) Function since there in only one y-value for each x-value.
d) i) D = {1}, R = {2, 5, 9, 10}
ii) Not a function since there are four y-values for $x = 1$.

2. a) i) D = {1, 3, 4, 6}, R = {1, 2, 5}
ii) Function since there in only one value in the range for each value in the domain.
b) i) D = {1, 2, 3}, R = {4, 5, 6}
ii) Not a function since there are two values in the range for the value of 1 in the domain.
c) i) D = {1, 2, 3}, R = {4}
ii) Function since there is only one value in the range for each value in the domain.
d) i) D = {2}, R = {4, 5, 6}
ii) Not a function since there are three values in the range for the value of 2 in the domain.

3. a) i) $D = \{x \mid 2 \le x \le 13\}$, $R = \{y \mid 2 \le y \le 7\}$
ii) Function since a vertical line passes through only one y-value at any point.
b) i) $D = \{x \mid 0 \le x \le 6\}$, $R = \{y \mid 0 \le y \le 9\}$
ii) Not a function since a vertical line passes through two points when $x = 1$ and when $x = 5$.
c) i) $D = \{x \mid -2 \le x \le 4\}$, $R = \{y \mid -4 \le y \le 5\}$
ii) Not a function since a vertical line passes through two points at several values of x.
d) i) $D = \{x \mid x \in \mathbf{R}\}$, $R = \{y \mid y \ge 2\}$
ii) Function since a vertical line passes through only one y-value at any point.

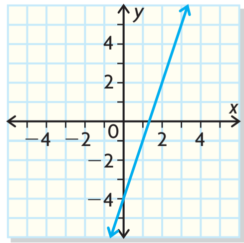
4. a) Function since there is only one y-value for each x-value.
b) Not a function since there are two y-values for $x = 1$.
c) Function since there is only one y-value for each x-value.
d) Not a function since there are two y-values for $x = 1$.

5. a) function
b) not a function; $(-5, -7)$ or $(-5, -2)$

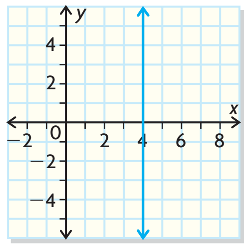
6. a) Function since a vertical line will pass through only one y-value for any x-value.
D = {0, 1, 2, 3, 4}, R = {2, 4, 6, 8, 10}
b) Not a function since a vertical line passes through two points at $x = 0$ and $x = 1$.
D = {0, 1, 2}, R = {2, 4, 6, 8, 10}
c) Not a function since a vertical line passes through two points at $x = 1$ and $x = 3$.
D = {1, 3, 5}, R = {1, 2, 3, 4, 5}
d) Function since a vertical line will pass through only one y-value for any x-value.
D = {2, 4, 6, 8, 10}, R = {1}

7. a) Function since a vertical line will pass through only one y-value for any x-value.
$D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \ge 1\}$
b) Not a function since a vertical line passes through two points at several values of x.
$D = \{x \in \mathbf{R} \mid x \ge 1\}$, $R = \{y \in \mathbf{R}\}$
c) Function since a vertical line will pass through only one y-value for any x-value.
$D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R}\}$
d) Not a function since a vertical line passes through two points at several values of x.
$D = \{x \in \mathbf{R} \mid -3 \le x \le 3\}$, $R = \{y \in \mathbf{R} \mid -3 \le y \le 3\}$

8. a)



b)



c) A vertical line cannot be the graph of a linear function because there are infinitely many y-values for the one x-value. Also, it doesn't pass the vertical-line test.

9. a) (Sonia, 8), (Jennifer, 10), (Afzal, 9), (Tyler, 8)
b) D = {Sonia, Jennifer, Afzal, Tyler}, R = {7, 8, 9, 10}
c) Yes, because there is only one arrow from each student to one mark.

10. a) Yes, because each mammal has only one resting pulse rate.
b) Yes, because each mammal has only one resting pulse rate.

11. a) outdoor temperature: domain; heating bill: range
b) time spent doing homework: domain; report card mark: range
c) person: domain; date of birth: range
d) number of cuts: domain; number of slices of pizza: range

12. a) This represents a function because for each size and type of tire there is only one price.
b) This might not represent a function because more than one tire size could have the same price.

13. a) The date is the independent variable. The temperature is the dependent variable.
b) The domain is the set of dates for which a temperature was recorded.
c) The range is the set of outdoor temperatures in degrees Celsius.
d) One variable is not a function of the other because during a certain date the outdoor temperature could vary over several degrees, and given any temperature, there could have been multiple days for which that temperature was recorded.

14. For example,

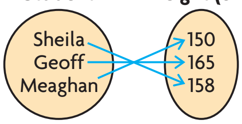
Function

Definition:
A function is a relation in which there is only one y-value (the dependent variable) for every x-value (the independent variable).

Rules:
- A relation in which each element of the domain corresponds to only one element of the range.
- Use a vertical line to check whether the graph of the relation is a function. If the line crosses only one point along the graph, then the relation is a function.

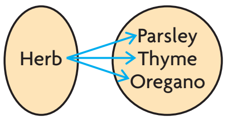
Examples:

x	y
−3	2
−2	1
−1	0
0	−1
1	−2
2	−3



Non-examples:

x	y
3	5
2	3
1	1
3	−5
2	−3
1	−1



15. 0 to 66 best represents the range in the relationship. Since height is the range, the height would start at 66 m, when the rock rolls off the cliff, and would end at 0 m, when the rock hits the ground.

16. The most reasonable set of values for the domain is positive integers. The domain is the set of items sold, and thus no negative integer could appear in the domain.

Lesson 1.2, pp. 24–25

1.

Time (s)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Height (m)	10	9.84	9.36	8.56	7.44	6.00	4.24	2.16	0.00
First Differences	0.16	0.48	0.80	1.21	1.44	1.76	2.08	2.16	
Second Differences	0.32	0.32	0.41	0.23	0.32	0.32	0.08		

a) Distance as a function of time, $d(t)$, is a quadratic function of time since most of the second differences are close to or equal to 0.32, but the first distances are not close to a fixed number.
b) $D = \{t \mid 0 \leq t \leq 0.8, t \in \mathbf{R}\}$, $R = \{d \mid 0 \leq d \leq 0, d \in \mathbf{R}\}$

2. **a)** $f(x) = 60x$
b) The degree is 1. The function is linear.
c) \$1800
d) $D = \{x \mid 0 \leq x \leq 60, x \in \mathbf{W}\}$, $R = \{f(x) \mid 0 \leq f(x) \leq 3600, f(x) \leq \mathbf{W}\}$

3. **a)** 1; linear **c)** 2; quadratic
b) 2; quadratic **d)** 1; linear

4.

Time (s)	0	1	2	3	4	5
Height (m)	0	15	20	20	15	0
First Differences	15	5	0	−5	−15	
Second Differences	−10	−5	−5	−10		

Since the second differences are not constant, the relationship is neither linear nor quadratic.

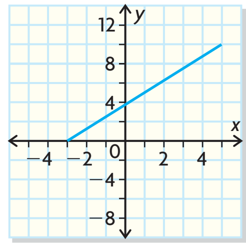
5.

Time (h)	0	1	2	3
Bacteria Count	12	23	50	100
First Differences	11	27	50	
Second Differences	16	23		

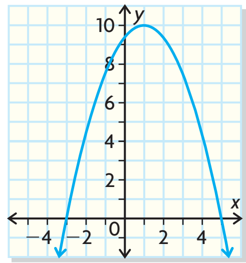
Based on the data given and the differences, the data are neither linear nor quadratic.

6. **a)** 2; quadratic **c)** 2; quadratic
b) 2; quadratic **d)** 1; linear

7. **a)**



b)

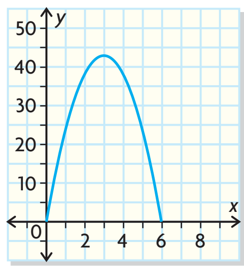


8. **a)** $f(t) = 29.4t - 4.9t^2$
b) The degree is 2, so the function is quadratic.
c)

Time (s)	0	1	2	3	4	5	6
Height (m)	0	24.5	39.2	44.1	39.2	24.5	0
First Differences	24.4	14.7	4.9	−4.9	−14.7	−24.5	
Second Differences	−9.7	−9.8	−9.8	−9.8	−9.8		

Since the second differences are constant, then the function is quadratic.

d)



e) The ball is at its greatest height at 3 s. $f(3) = 44.1$
f) The ball is on the ground at 0 s and 6 s. $f(0) = 0$ and $f(6) = 0$

9. Table of values: A table of values to check the differences. If the first differences are constant, then it is a linear function. If the second differences are constant, then it is a quadratic function.
Graph: The graph of a linear function looks like a line, and the graph of a quadratic function looks like a parabola.

Answers

Equation: The degree of an equation will determine the type of function. If the degree is 1, then the function is linear. If the degree is 2, then the function is quadratic.

10. **a)** $I(x) = \$50 + \$0.05x$, x is the number of bags of peanuts sold.
b) $R(x) = \$2.50x$, x is the number of bags of peanuts sold.
c) 21

Lesson 1.3, pp. 32–35

1. The y-value is $\frac{1}{2}$ when the x-value is 3.

2. **a)** 1 **b)** 4 **c)** 2

3. **a)** $f(-2) = -7; f(0) = 5; f(2) = -7;$
$f(2x) = -3(2x)^2 + 5 = -12x^2 + 5$
b) $f(-2) = 21; f(0) = 1; f(2) = 13;$
$f(2x) = 4(2x)^2 - 2(2x) + 1 = 16x^2 - 4x + 1$

4. **a)** 72 cm; This represents the height of the stone above the river when the stone was released.
b) 41.375 cm; This represents the height of the stone above the river 2.5 s after the stone was released.
c) The stone is 27.9 cm above the river 3 s after it was released.

5. **a)** 1 **b)** 8 **c)** 41 **d)** -7

6. **a)** D = {−2, 0, 2, 3, 5, 6}, R = {1, 2, 3, 4, 5}
b) **i)** 4 **ii)** 2 **iii)** 5 **iv)** -2
c) They are not the same function because of order of operations.
d) $f(2) = 5$ corresponds to (2, 5). 2 is the x-coordinate of the point. $f(2)$ is the y-coordinate of the point.

7. 6; the y-value when $x = 2$ is 6

8. The point on the graph is $(-2, 6)$ because the y-value is 6 when $x = -2$.

9. **a)** 1; 19 **b)** -1; -9 **c)** 13; 23 **d)** -4; 44

10. **a)** **i)** 5 **ii)** 8 **iii)** 11 **iv)** 14 **v)** 3 **vi)** 3
b) first differences

11. **a)** **i)** 9 **ii)** 4 **iii)** 1 **iv)** 0 **v)** 2 **vi)** 2
b) second differences

12. **a)** 17
b) y-coordinate of the point on the graph with x-coordinate 2
c) $x = 1$ or $x = 5$
d) No, $f(3) = -1$

13. **a)** x represents one of the numbers. $(10 - x)$ represents the other number. $P(x)$ represents the product of the two numbers.
b) The domain is the set of all whole numbers between 0 and 10.
c)

x	0	1	2	3	4	5	6	7	8	9	10
P(x)	0	9	16	21	24	25	24	21	16	9	0

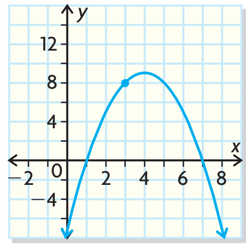
d) 5 and 5; 25; The largest product would occur when both numbers are the same.

14. **a)**

Fertilizer, x (kg/ha)	0	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Yield, y(x) (tonnes)	0.14	0.45	0.70	0.88	0.99	1.04	1.02	0.93	0.78

b) 1.25 kg/ha
c) The answer changes because the table gives only partial information about the function.

15. For example, for the function $f(x) = -x^2 + 8x - 7$, if I substitute $x = 3$ into the function, then $f(3) = -(3)^2 + 8(3) - 7 = 8$. This means that the y-value is 8 when the x-value is 3. This also corresponds to the point (3, 8) on the graph of the function $f(x)$, where 3 is the x-coordinate and 8 is the y-coordinate.

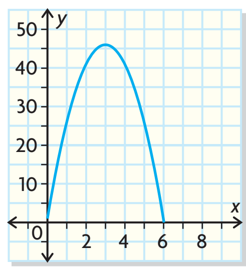


16. **a)** $h(0)$ represents the height of the glider when it is launched, at 0 s.
b) $h(3)$ represent the height of the glider at 3 s.
c) The glider is at its lowest point between 7 and 8 s, about 7.5 s. The vertical distance between the top of the tower and the glider at this time is 14.0625 m.

17. **a)**

Time (s)	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8
Height (m)	1	14.75	26	34.75	41	44.75	46	44.75	41	34.75	26	14.75	1	−15.25	−34	−55.25	−79

b)



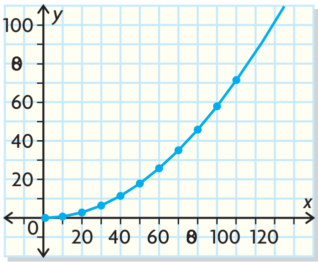
c) 3 s
d) 46 m
e) about 6.1 s

Mid-Chapter Review, p. 37

1. **a)** Not a function because there are two y-values for the x-value of 1.
b) Function because for every x-value there is only one y-value.
c) Not a function because there are two y-values for the x-value of 7.
d) Function because for every x-value there is only one y-value.
e) Not a function because the vertical line test isn't passed.

2. **a)** For f: D = {1, 2, 3}, R = {2, 3, 4}. For g: D = {1, 2, 3}, R = {0, 1, 2, 3, 4}.
b) f is a function because there is only one y-values for each x-value. g is not a function because there are two y-values for an x-value of 2, and there are two y-values for an x-value of 3.

3. a) D = $\{x \mid -3 \le x \le 3, x \in \mathbf{R}\}$, R = $\{y \mid -3 \le y \le 3, y \in \mathbf{R}\}$, not a function because it fails the vertical-line test
   b) D = $\{x \mid x \le 0, x \in \mathbf{R}\}$, R = $\{y \mid y \in \mathbf{R}\}$, not a function because it fails the vertical-line test
4. a) quadratic (second differences are all 12.4)
   b) between 1 and 1.5
   c) between 99.2 and 155
5. a)



   b) 120 km/h
   c) A quadratic relation can model the data since the second differences are almost constant.
6. a) -9 b) $4m - 5$ c) $2n - 4$
7. a) 6 b) $18m^2 - 9m + 1$ c) 1

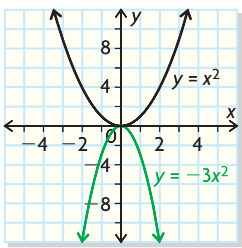
Lesson 1.4, p. 40

1. a) $a = 1, h = 4, k = 0$
   b) $a = 1, h = 0, k = 5$
   c) $a = 1, h = -2, k = 0$
   d) $a = 1, h = 0, k = -3$
   e) $a = -1, h = 0, k = 0$
   f) $a = 2, h = 0, k = 0$
   g) $a = -\frac{1}{2}, h = 0, k = 0$

Lesson 1.5, pp. 47–50

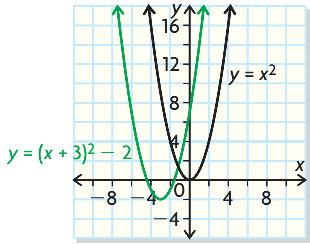
1. a) (vi) because it opens down and the vertex is at $(2, -3)$
   b) (iv) because it opens down and the vertex is at $(0, -4)$
   c) (i) because it opens up and the vertex is at $(0, 5)$
   d) (v) because it opens up and the vertex is at $(-2, 0)$
   e) (iii) because it opens up and the vertex is at $(2, 0)$
   f) (ii) because it opens down and the vertex is at $(-4, 2)$
2. a) $a = -3, h = 0, k = 0$; opens down, vertically stretched by a factor of 3

x	y
−3	−27
−2	−12
−1	−3
0	0
1	−3
2	−12
3	−27



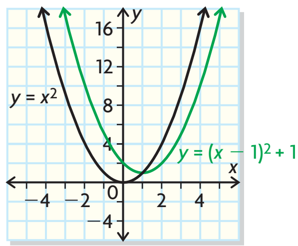
   b) $a = 1, h = -3, k = -2$; opens up, move 3 units to the left and 2 units down

x	y
−3	−2
−2	−1
−1	2
0	7
1	14
2	23
3	34



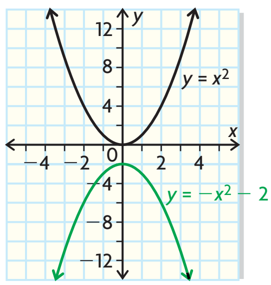
   c) $a = 1, h = 1, k = 1$; opens up, move 1 unit to the right and 1 unit up

x	y
−3	17
−2	10
−1	5
0	2
1	1
2	2
3	5



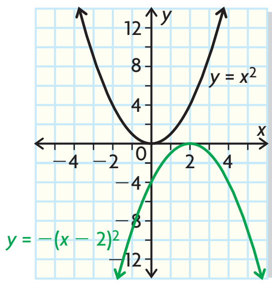
   d) $a = -1, h = 0, k = -2$; opens down, move 2 units down

x	y
−3	−11
−2	−6
−1	−3
0	−2
1	−3
2	−6
3	−11



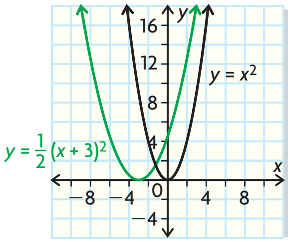
   e) $a = -1, h = 2, k = 0$; opens down, move 2 units to the right

x	y
−3	−25
−2	−16
−1	−9
0	−4
1	−1
2	0
3	−1



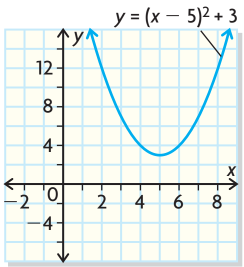
f) $a = \frac{1}{2}$; $h = -3$, $k = 0$; opens up, move 3 units to the left, and vertically compress by a factor of 2

x	y
−3	0
−2	0.5
−1	2
0	4.5
1	8
2	12.5
3	18

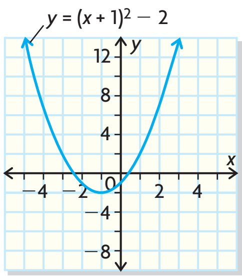


3. **a)** (iv) **b)** (i) **c)** (iii) **d)** (ii)

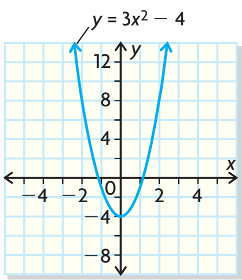
4. **a)** Move 5 units to the right and 3 units up.



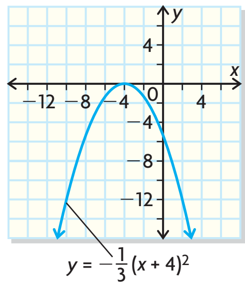
b) Move 1 unit to the left and 2 units down.



c) Vertically stretch by a factor of 3 and move 4 units down.



d) Reflect graph in x-axis, vertically compress by a factor of 3, and move 4 units to the left.



5. **a)** $y = 5x^2$ **c)** $y = -(x - 2)^2$

b) $y = \frac{1}{2}x^2$ **d)** $-\frac{1}{3}x^2 + 2$

6. **a)** $y = (x - 2)^2 - 6$ **c)** $y = x^2 - 1$

b) $y = (x + 2)^2 - 4$ **d)** $y = (x - 5)^2 - 5$

7. **a)** $y = x^2 + 4$ **d)** $y = 2(x - 2)^2$

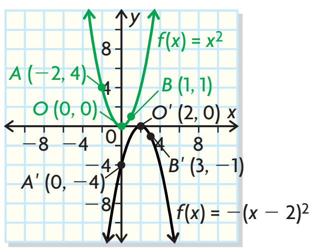
b) $y = (x - 5)^2$ **e)** $y = -0.5(x + 2)^2$

c) $y = -(x - 5)^2$ **f)** $y = -0.5(x - 1)^2$

8. **a)** **i)** The shape of the graph $f(x) = -(x - 2)^2$ is the same shape as the graph of $f(x) = x^2$.

ii) The vertex is at (2, 0) and the axis of symmetry is $x = 2$.

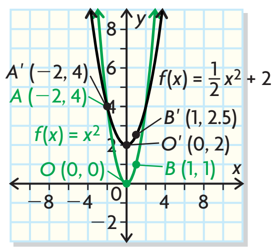
iii), iv)



b) **i)** The shape of the graph of $f(x) = \frac{1}{2}x^2 + 2$ is the same as the graph of $f(x) = x^2$ compressed vertically by a factor of 2.

ii) The vertex is at (0, 2) and the axis of symmetry is $x = 0$.

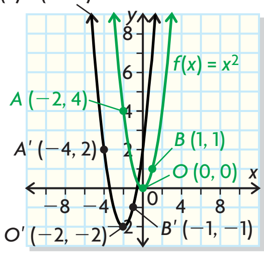
iii), iv)



c) i) The graph of $f(x) = (x + 2)^2 - 2$ is the same shape as the graph of $f(x) = x^2$.

ii) The vertex is at $(-2, -2)$ and the axis of symmetry is $x = -2$.

iii), iv) $f(x) = (x + 2)^2 - 2$



9. a) $y = (x - 2)^2$

b) $y = (x + 4)^2$

c) $y = (x + 4)^2 - 5$

d) $y = \frac{1}{4}x^2$

e) $y = 2(x + 4)^2$

f) $y = 3(x - 2)^2 - 1$

10. a) Either $a > 0$ and $k < 0$ or $a < 0$ and $k > 0$

b) $a \in \mathbf{R}$ and $k = 0$

c) Either $a > 0$ and $k > 0$ or $a < 0$ and $k > 0$

11. a) If the graph of the function for Earth, $h(t) = -4.9t^2 + 100$, is the base graph, then the graph for Mars is wider, the graph for Saturn is slightly narrower, and the graph for Neptune is slightly wider.

b) Neptune

c) Mars

12. a) The x-coordinates are decreased by 7 and the y-coordinates are unchanged.

b) The x-coordinates are unchanged and the y-coordinates are increased by 7.

c) The x-coordinates are increased by 4 and the y-coordinates are multiplied by -2.

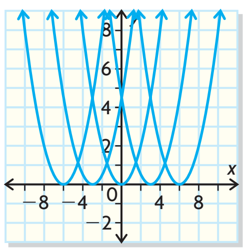
d) The x-coordinates are unchanged and the y-coordinates are multiplied by $-\frac{1}{2}$ and decreased by 4.

13. a) The graphs get narrower and narrower.

b) The graphs get wider and wider.

14. a) $y = -2x^2$, $y = -2(x - 2)^2$, $y = -2(x - 4)^2$, $y = -2(x + 2)^2$, $y = -2(x + 4)^2$

b) Answers may vary. For example, $y = 0.5x^2$, $y = 0.5(x - 6)^2$, $y = 0.5(x - 3)^2$, $y = 0.5(x + 3)^2$, $y = 0.5(x + 6)^2$.



Lesson 1.6, pp. 56–58

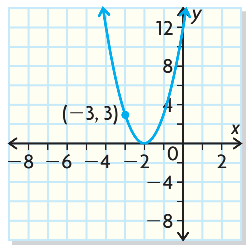
1. a) horizontal translation 2 units to the left and vertical stretch by a factor of 3

b) horizontal translation 3 units to the right, reflection in x-axis, vertical stretch by a factor of 2, and vertical translation 1 unit up

c) vertical compression by a factor of 3 and vertical translation 3 units down

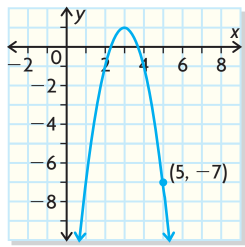
d) horizontal translation 2 units to the left, reflection in x-axis, vertical compression by a factor of 2, and vertical translation 4 units up

2. a)



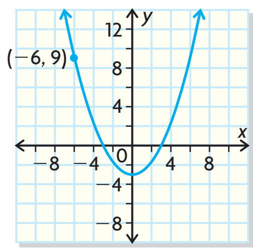
$f(-3) = 3(-3 + 2)^2 = 3(-1)^2 = 3$

b)



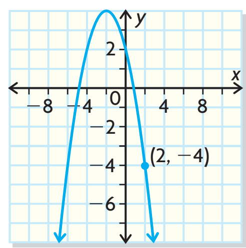
$f(5) = -2(5 - 3)^2 + 1 = -2(2)^2 + 1 = -7$

c)



$f(-6) = \frac{1}{3}(-6)^2 - 3 = 12 - 3 = 9$

d)



$f(2) = -\frac{1}{2}(2 + 2)^2 + 4 = -8 + 4 = -4$

3. a) (iv) **b)** (i) **c)** (iii) **d)** (ii)

4. a) vertical compression by a factor of 2 and a vertical translation 2 units down; $y = \frac{1}{2}x^2 - 2$

b) horizontal translation 4 units to the right and reflection in x-axis; $y = -(x - 4)^2$

c) reflection in x-axis, vertical stretch by a factor of 2, and a vertical translation 3 units down; $y = -2x^2 - 3$

d) horizontal translation 4 units to the left, reflection in x-axis, and a vertical translation 2 units down; $y = -(x + 4)^2 - 2$

5. **a)** $y = 2(x - 4)^2 - 1$

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

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

d) $y = \frac{1}{2}(x - 2)^2 - 2$

e) $y = -2(x + 1)^2 + 4$

f) $y = (x - 4)^2 + 5$

6. **a)** $y = 5(x - 2)^2 - 4$

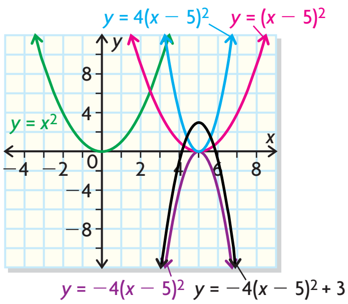
b) $y = \frac{1}{2}(x - 2)^2 - 4$

c) $y = x^2 - 4$

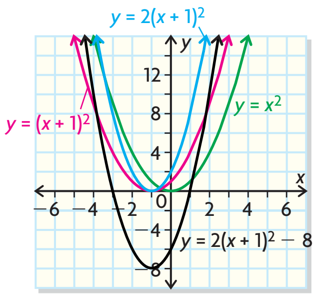
d) $y = (x - 2)^2 - 1$

e) $y = -(x - 4)^2 - 8$

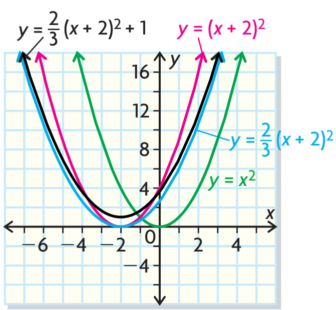
7. **a)** horizontal translation 5 units to the right, vertical stretch by a factor of 4, vertical reflection in the x-axis, and vertical translation 3 units up



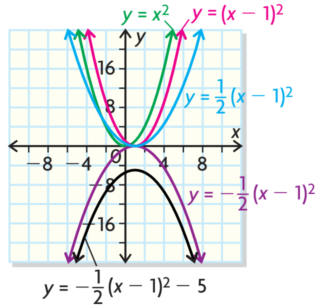
b) horizontal translation 1 unit to the left, vertical stretch by a factor of 2, and vertical translation 8 units down



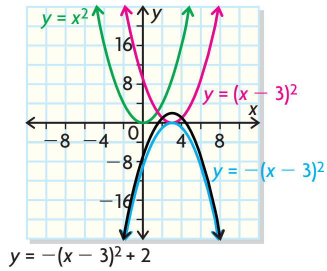
c) horizontal translation 2 units to the left, vertical compression by a factor of $\frac{3}{2}$, and vertical translation 1 unit up



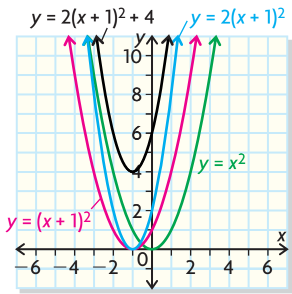
d) horizontal translation 1 unit to the right, vertical compression by a factor of 2, vertical reflection in x-axis, and vertical translation 5 units down



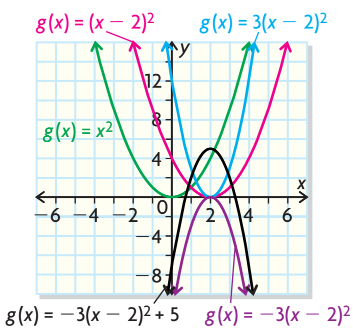
e) horizontal translation 3 units to the right, vertical reflection in the x-axis, and vertical translation 2 units up



f) horizontal translation 1 unit to the left, vertical stretch by a factor of 2, and vertical translation 4 units up



8.



9. a) $y = x^2 + 2, y = 2x^2 + 2, y = \frac{1}{2}x^2 + 2, y = -x^2 + 2,$
$y = -2x^2 + 2, y = -\frac{1}{2}x^2 + 2$
b) $y = x^2 + 6, y = x^2 + 4, y = x^2 + 2, y = x^2, y = x^2 - 2,$
$y = x^2 - 4, y = x^2 - 6$

10. a) horizontal translation 6 units to the left, vertical compression by a factor of 4, vertical reflection in the *x*-axis, and vertical translation 2 units up
b) $y = -\frac{1}{4}(x + 6)^2 + 2$

11. a) horizontal translation 7 units to the left, vertical stretch by a factor of 2, and vertical translation 3 units down
b) vertical stretch by a factor of 2 and vertical translation 7 units up
c) horizontal translation 4 units to the right, vertical stretch by a factor of 3, vertical reflection in the *x*-axis, and vertical translation 2 units up
d) vertical stretch by a factor of 3, vertical reflection in the *x*-axis, and vertcial translation 4 units down

12. a) constant: a, k; changed: h
b) constant: a, h; changed: k
c) constant: h, k; changed: a

Lesson 1.7, pp. 63–65

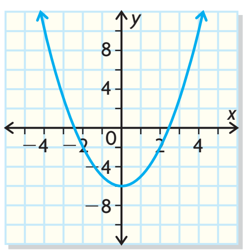
1. a) Domain is all real numbers and range is all real numbers.
b) horizontal lines: domain is all real numbers, range is the *y*-value of the horizontal line
vertical lines: domain is the *x*-value of the vertical line, range is all real numbers

2. a) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \le 5\}$; $f(x)$ is a quadratic function that opens down and the vertex is at $(-3, 5)$, which is a maximum.
b) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \ge 5\}$; $f(x)$ is a quadratic function that opens up and the vertex is at $(-1, 5)$, which is a minimum.
$f(x) = 2x^2 + 4x + 7$
c) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R}\}$; $f(x)$ is a linear function with nonzero slope.
d) $D = \{x = 5\}, R = \{y \in \mathbf{R}\}$; $x = 5$ is a vertical line.

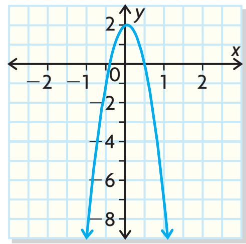
3. $D = \{t \in \mathbf{R} \mid 0 \le t \le 20\}, R = \{f(t) \in \mathbf{R} \mid 0 \le f(t) \le 500\}$; Since t represents time, t cannot be negative or greater than 20 (after $t = 20$ the height is negative). Since $f(t)$ represents the height, the height is positive between 0 and 500.

4. a) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \le 2\}$
b) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R}\}$
c) $D = \{x \in \mathbf{R}\}, R = \{y = 8\}$
d) $D = \{x = 4\}, R = \{y \in \mathbf{R}\}$
e) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \ge -4\}$
f) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R}\}$

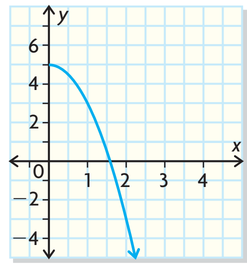
5. $D = \{x \in \mathbf{R} \mid 1 \le x \le 11\}, R = \{y \in \mathbf{R} \mid 12 \le y \le 36\}$

6. a)


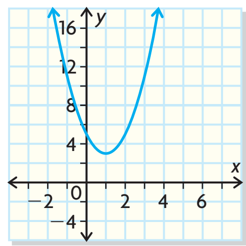
$D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \ge -6\}$

b)


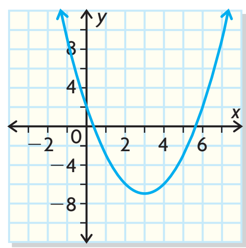
$D = \{x \in \mathbf{R}\}, R = \left\{y \in \mathbf{R} \mid y \le \frac{81}{40}\right\}$

c)


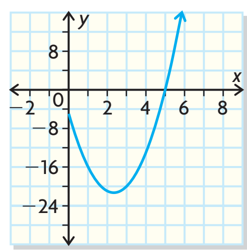
$D = \{x \in \mathbf{R} \mid x \ge 0\}, R = \{y \in \mathbf{R} \mid y \le 5\}$

d)


$D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \ge 3\}$

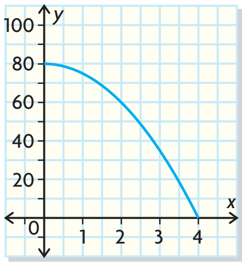
e)


$D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \ge -7\}$

f)


$D = \{x \in \mathbf{R} \mid x \ge 0\}, R = \{y \in \mathbf{R} \mid y \ge -21.33\}$

7. a)



b) Since t represents time, $t \geq 0$. Since the height of the pebble is negative after $t = 4$, $t \leq 4$.

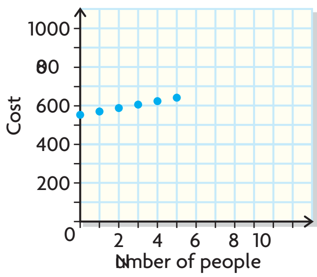
c) The bridge is 80 m high since the maximum height of 80 m occurs when $t = 0$ s, when the pebble is dropped.

d) It takes 4 s for the pebble to hit the water since the height at $t = 4$ s is 0 m.

e) $D = \{t \in \mathbf{R} \mid 0 \leq t \leq 4\}$, $R = \{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 80\}$

8. a)

Number of People, n	Cost, $C(n)$
0	\$550
1	\$568
2	\$586
3	\$604
4	\$622
5	\$640



b) $C(n) = 550 + 18n$

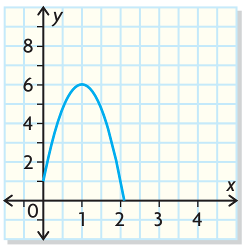
c) $D = \{n \in \mathbf{R} \mid n \geq 0\}$, $R = \{C(n) \in \mathbf{R} \mid C(n) \geq 550\}$

9. a) $d(t) = -10t$

b) 5 h

c) $D = \{t \in \mathbf{R} \mid t \geq 0\}$, $R = \{d(t) \in \mathbf{R} \mid 3000 \geq d(t) > 0\}$

10. a)



b) t represents time, which is never negative and is between 0 and 2.095 s, when the ball hits the ground.

c) 6 m

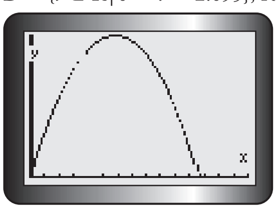
d) 1 s

e) 2.095 s

f) never

g) $D = \{t \in \mathbf{R} \mid 0 \leq t \leq 2.095\}$, $R = \{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 6\}$

11. a)



b) \$0.58

c) $D = \{x \in \mathbf{R} \mid 0 \leq x \leq 1.17\}$, $R = \{R(x) \in \mathbf{R} \mid 0 \leq R(x) \leq 102.08\}$

12. a) The values of the domain and range must make sense for the situation.

b) Restrictions are necessary in order for the situation to make sense. For example, it doesn't make sense to have a negative value for time or a negative value for height in most situations.

13. a) $D = \{r \in \mathbf{R} \mid r \geq 0\}$

b) $R = \{A(r) \in \mathbf{R} \mid A(r) \geq 0\}$

Chapter Review, pp. 68–69

1. a) $D = \{a \in \mathbf{R} \mid 1 \leq a \leq 12\}$

b) $R = \{m \in \mathbf{R} \mid 11.5 \leq m \leq 49.5\}$

c) function

2. quadratic function

3. a) 1; linear

b) 2; quadratic

c) 3; neither linear nor quadratic

4. a) $f(-1) = 7$

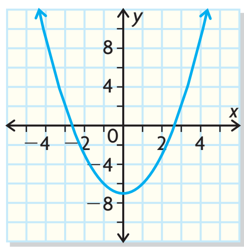
b) $f(3) = 19$

c) $f(0.5) = 0.25$

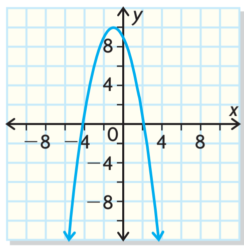
5. a) 5 **c)** 31

b) 4 **d)** 4

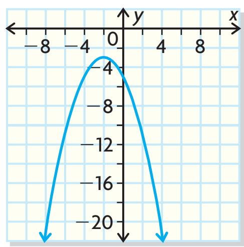
6. a) vertex at $(0, -7)$, $x = 0$, opens up



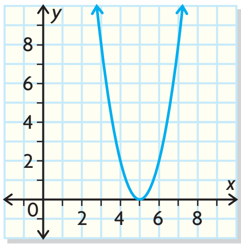
b) vertex at $(-1, 10)$, $x = -1$, opens down



c) vertex at $(-2, -3)$, $x = -2$, opens down



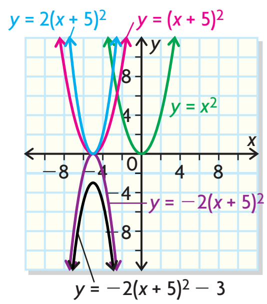
d) vertex at (5, 0), $x = 5$, opens up



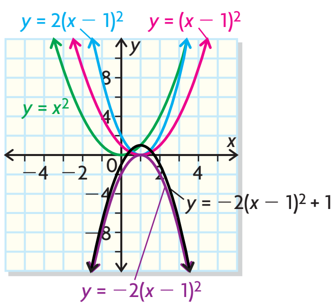
7. a) vertical translation 7 units down
b) horizontal translation 1 unit to the left, vertical reflection in x-axis, and vertical translation 10 units up
c) horizontal translation 2 units to the left, vertical compression by a factor of 2, vertical reflection in x-axis, and vertical translation 3 units down
d) horizontal translation 5 units to the right and vertical stretch by a factor of 2

8. a) i) vertical stretch by a factor of 5 and vertical translation 4 units down
ii) horizontal translation 5 units to the right and vertical compression by a factor of 4
iii) horizontal translation 5 units to the left, vertical stretch by a factor of 3, vertical reflection in the x-axis, and vertical translation 7 units down
b) i) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq -4\}$
ii) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq 0\}$
iii) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq -7\}$

9. a) horizontal translation 5 units to the left, vertical stretch by a factor of 2, vertical reflection in the x-axis, and vertical translation 3 units down.
b)



10. a)



b) $y = -2(x - 1)^2 + 1$

11. a) $y = 2x^2 - 8$
b) $(0, -4)$
c) The graphs are different because the operations of multiplying by 2 and subtracting 4 are done in different orders for (a) and (b).
d) vertical stretch by a factor of 2, vertical translation 4 units down

12. a) 1.34 m
b) 9 m
c) 1.343 75 m
d) no
e) 2.6052 s

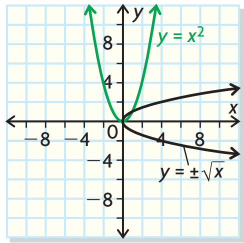
13. a) 57 m
b) 6.4 s
c) $D = \{t \in \mathbf{R} \mid 0 \leq t \leq 6.4\}$, $R = \{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 57\}$

14. 11.75 s

Chapter Self-Test, p. 70

1. a) $D = \{1, 3, 4, 7\}$, $R = \{1, 2\}$; function since there is only one y-value for each x-value
b) $D = \{1, 3, 4, 6\}$, $R = \{1, 2, 5\}$; function since there is only one value in $g(x)$ for each value in x
c) $D = \{1, 2, 3\}$, $R = \{2, 3, 4, 5\}$; not a function since there are two y-values for $x = 1$ and it fails the vertical-line test

2. A function is a relation in which there is only one y-value for each x-value. For example, $y = x^2$ is a function, but $y = \sqrt{x}$ is not a function.



3.

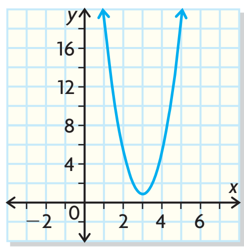
Time (s)	0	1	2	3	4	5
Height (m)	0	30	40	40	30	0
First Differences	30	10	0	−10	−30	
Second Differences	−20	−10	−10	−20		

Since the first differences and the second differences are not constant, the data does not represent a linear or a quadratic function.

4. a) $f(2) = 3(2)^2 - 2(2) + 6 = 14$
b) $f(x - 1) = 3(x - 1)^2 - 2(x - 1) + 6 = 3x^2 - 8x + 11$

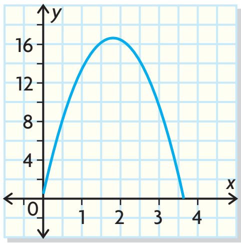
5. a) 28
b) the y-coordinate when the x-coordinate is 1
c) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq 1\}$
d) It passes the vertical line test.
e) It's a quadratic that opens up.

6. a) horizontal translation 3 units to the right, vertical stretch by a factor of 5, and vertical translation 1 unit up
b) minimum value is 1 when $x = 3$; there is no maximum value.
c) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq 1\}$
d)



Answers

7. **a)**



b) *t* represents time, which can never be negative.
c) 16.7 m
d) 1.8 s
e) 3.6 s
f) $D = \{t \in \mathbf{R} \mid 0 \leq t \leq 3.6\}$, $R = \{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 16.7\}$

Chapter 2

Getting Started, pp. 74–76

1. **a)** (vii) **b)** (iv) **c)** (viii) **d)** (vi) **e)** (i) **f)** (iii) **g)** (ii) **h)** (v)

2. **a)** $-6x + y$ **b)** xy **c)** $3x - 3y + 3$ **d)** $-9a - 7b - 7ab$

3. **a)** x^5 **b)** $10x^3$ **c)** x^2 **d)** $2x^2$

4. **a)** $(x)(x) = x^2$ **b)** $(2x)(4x) = 8x^2$

5. **a)** $9x - 24$ **b)** $-32x^2 + 8x - 4$ **c)** $14x^2 - 10x + 8$ **d)** $-5d^3 - 11d^2 - 6d + 36$ **e)** $6x^3 + 10x^2$ **f)** $-5x^4 + 15x^3 - 20x^2$

6. **a)** $2(x - 5)$ **b)** $6(x^2 + 4x + 5)$ **c)** $5(5x^2 + 4x - 20)$ **d)** $x^3(7x + 12 - 9x^2)$

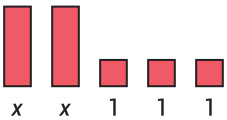
7. **a)** x^5 **b)** $-30x^7$ **c)** $15x^7$ **d)** $2x^3$

8. **a)** (i) and (v) **b)** (ii), (iv), and (vi) **c)** (iii) **d)** (iii) and (iv)

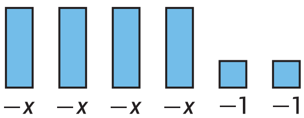
9. **a)** 8 **b)** 8 **c)** 18 **d)** x **e)** $3x + 2$ **f)** $5x$

10. **a)** $2 \times 3 \times 13$ **b)** 7×3^2 **c)** $5^2 \times 11^2$ **d)** 41

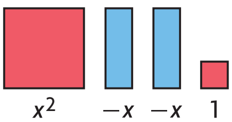
11. **a)**



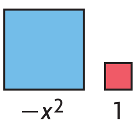
b)



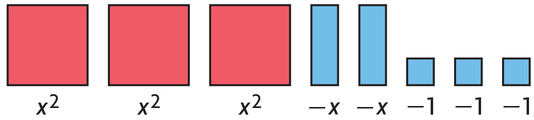
c)



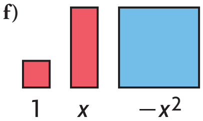
d)



e)



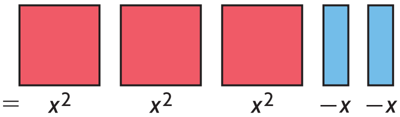
f)



12. **a)** (iii) **b)** (ii) **c)** (i)

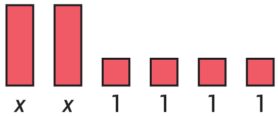
13. **a)**

$3x^2 - 2x =$



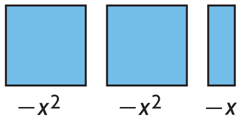
b)

$2x + 4 =$



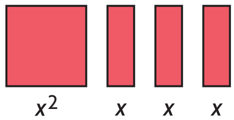
c)

$-2x^2 - x =$



d)

$x^2 + 3x =$



14. **a)** Agree: Area = length × width, in which length and width are factors of the product Area.
b) Disagree: factors are integers; Agree: factors are terms that multiply together to make the product.
c) Disagree: -2 and $-x - 3$ are other factors of $2x + 6$.

Lesson 2.1, pp. 85–87

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

2. **a)** $x^2 + 4x - 21$ **b)** $a^2 + 12a + 36$ **c)** $4x^2 - 20x + 25$ **d)** $m^2 - 81$

3. **a)** $3x^2 - 3x - 90$ **b)** $a^2 - 2a + 7$ **c)** $-3n^2 + 2n + 4$ **d)** $-6x^2 + 24x + 1$

4. **a)** $(x + 1)(2x + 2) = 2x^2 + 4x + 2$
b) $(2x - 1)(x + 3) = 2x^2 + 5x - 3$

5. **a)** $12x^2 + 7x - 10$ **b)** $45x^2 + 60x + 20$ **c)** $-14x^2 - 12x + 19$ **d)** $4a^2 + 29a + 32$ **e)** $-20n^2 - 2n$ **f)** $4x^2 + 75$

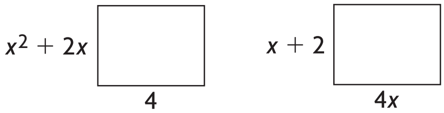
6. **a)** 11 **b)** -2 **c)** $-2x^2 - x + 6$ **d)** -22
e) $-2x^2 - x + 6$ evaluated for $x = -4$ is -22. It was shown in part (c) that the factors of $-2x^2 - x + 6$ are $(3 - 2x)$ and $(x + 2)$. Parts (a) and (b) showed that $(3 - 2x)$ and $(x + 2)$ evaluated for $x = 4$ are 11 and -2, respectively, the

product of which is −22. So, parts (a)–(b) show that if you evaluate two expressions for a specific number, x, and multiply the results of the evaluation together, it is equal to the product of those two expressions evaluated for that same number, x.

7. **a)** $2x^2 - 10x$ **c)** $18x^2 + 27x - 35$
b) $a^2 - 2a - 63$ **d)** $11m^2 - 15m - 12$

8. The highest exponent comes from $2x$ times $3x$, or $6x^2$.

9. Answers may vary. E.g., 4 by $x^2 + 2x$ or $4x$ by $x + 2$



10. **a)** $(2x + 3)(2x - 4) = 4x^2 - 2x - 12$
b) $\frac{1}{2}(2x - 1)(4x + 2) = 4x^2 - 1$

11. **a)** πx^2 **b)** $\pi(x + 5)^2$ **c)** $10\pi x + 25\pi$

12. **a)** Answers may vary. E.g., $(6x^2 - 8x) + (-15x^2 - 18x) = -9x^2 - 26x$
b) Answers may vary. E.g., $(6x^2 - 8x) + (-15x^2 + 8x) = -9x^2$

13. **a)** Answers may vary. E.g., $(2x + 3)(2x - 4) = 4x^2 - 2x - 12$
b) Answers may vary. E.g., $(2x + 3)(2x - 3) = 4x^2 - 9$

14. **a)** $6x^2 - xy - y^2$ **c)** $25m^2 - 49n^2$
b) $9a^2 - 30ab + 25b^2$ **d)** $-4x^2 - 10xy + 6y^2$

15. **a)** $(n + 1)^2 - n^2 = n^2 + 2n + 1 - n^2$
b) 12
c) 5, 12, 13
d) 7, 24, 25; 9, 40, 41; 11, 60, 61

Lesson 2.2, pp. 92–94

1. **a)** $6x^2 + 4x$; $2x$ **b)** $16x - 12x^2$; $4x$

2. **a)** 3 **b)** x

3. **a)** $2(2x^2 - 3x + 1)$ **c)** $(a + 7)(5a + 2)$
b) $5x(x - 4)$ **d)** $(3m - 2)(4m - 1)$

4. **a)** $-6x^2$; $6x$ **b)** $4x^2 + 16x$; $4x$

5. **a)** 6 **b)** $2x$ **c)** 2 **d)** −5

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

7. **a)** $2x - 1$ **b)** $m^2 - 2m + 2$

8. $2\pi r(r + 10)$

9. $2a(3a - 2) + 7(2 - 3a) = 2a(3a - 2) + 7(-1)(3a - 2)$
$= 2a(3a - 2) - 7(3a - 2)$
$= (3a - 2)(2a - 7)$

10. **a)** Answers may vary. E.g., $6x^2 + 6x = 6x(x + 1)$; $12x^2 + 18x = 6x(2x + 3)$; $6x^2 - 30x = 6x(x - 5)$
b) Answers may vary. E.g., $7x^2 + 7x + 7 = 7(x^2 + x + 1)$; $7x^2 + 14x + 70 = 7(x^2 + 2x + 10)$; $14x^2 + 7x + 7 = 7(2x^2 + x + 1)$

11. Both common factors divide evenly into the quadratic, but the first term is usually positive after factoring.

12. k must be a number that has a common factor with 6 and 12 but not with 6 and 4. So k can be any odd multiple of 3, such as ±3, ±9, ±15, ….

13. **a)** $n + 2$ **c)** $2n^2 + 4n + 4 = 2(n^2 + 2n + 2)$
b) $n^2 + (n + 2)^2$

14. If a polynomial has two terms and each term has a common factor, then this can be divded out of both terms. For example, $6x^2 + 8x = 2x(3x + 4)$.

15. **a)** $5xy(x - 2y)$ **c)** $(x + y)(3x - y)$
b) $5a^2b(2b^2 - 3b + 4)$ **d)** $(x - 2)(5y + 7)$

16. **a)** $(3a + b)(3x + 2)$ **c)** $(x + y)(x + y + 1)$
b) $(2x - 1)(5x - 3y)$ **d)** $(1 + x)(1 + y)$

Lesson 2.3, pp. 99–100

1. **a)** $x^2 + x - 6 = (x + 3)(x - 2)$
b) $x^2 - x - 12 = (x - 4)(x + 3)$

2. **a)** $(x + 5)$ **c)** $(x + 8)$
b) $(x + 4)$ **d)** $(x + 2)$

3. **a)** $(x + 5)(x + 4)$ **c)** $(m + 3)(m - 2)$
b) $(a - 5)(a - 6)$ **d)** $2(n + 5)(n - 7)$

4. **a)** $x^2 + 4x + 3 = (x + 3)(x + 1)$
b) $x^2 - 3x - 10 = (x - 5)(x + 2)$

5. **a)** $(x + 6)$ **b)** $(x - 7)$ **c)** $(x + 5)$ **d)** $(x - 3)$

6. **a)** $(x - 5)(x - 2)$ **d)** $(w + 3)(w - 6)$
b) $(y - 5)(y + 11)$ **e)** $(x - 11)(x - 3)$
c) $(x - 5)(x + 2)$ **f)** $(n - 10)(n + 9)$

7. Answers may vary. E.g., $x^2 + 6x + 5$; $x^2 + 7x + 10$; $2x^2 + 16x + 30$

8. $(2 - x) = -(x - 2)$ and $(5 - x) = -(x - 5)$. When multiplied, the two minus signs become a positive sign.

9. **a)** $(a + 5)(a + 2)$ **d)** $(x - 4)(x + 15)$
b) $-3(x + 3)(x + 6)$ **e)** $(x + 5)(x - 2)$
c) $(z - 5)^2$ **f)** $(y + 6)(y + 7)$

10. $f(n) = (n - 3)(n + 1)$ when factored. If $n = 4$, the first factor becomes 1. Therefore, prime. Other numbers larger than 4 always produce two factors and are not prime.

11. We are looking for numbers that add to 0 and multiply to −16 to be able to factor.

12. **a)** Answers may vary. E.g., $b = 3$ and $c = 2$.
b) Answers may vary. E.g., $b = 5$ and $c = 6$.
c) Answers may vary. E.g., $b = 5$ and $c = 9$.

13. **a)** $k = 4$ or 5. These are the possible sums of the factors of 4. $2 + 2 = 4$ and $1 + 4 = 5$
b) $k = 4$, 3, or 0. These are the possible products of the addends of 4. $2 \times 2 = 4$, $1 \times 3 = 3$, and $0 \times 4 = 0$
c) $k = 4$ or 0. These are the possible numbers whose factors when added together give the same value. $2 \times 2 = 4$ and $2 + 2 = 4$. $0 \times 0 = 0$ and $0 + 0 = 0$

14. **a)** $(x + 5y)(x - 2y)$
b) $(a + 3b)(a + b)$
c) $-5(m - n)(m - 2n)$
d) $(x + y - 2)(x + y - 3)$

15. $\left(1 + \frac{3}{x}\right)(x + 4)$ or $\left(1 + \frac{4}{x}\right)(x + 3)$

Mid-Chapter Review, p. 103

1. **a)** $2x^2 - 18x + 15$ **c)** $-5x^2 - 15x$
b) $18n^2 + 8$ **d)** $-18a^2 + 2b^2$

2. $(2x + 1)$ and $(3x - 2)$; $6x^2 - x - 2$

3. $6x^2 + 5x - 4$

4. $5x$

5. **a)** $-4x(2x - 1)$ **c)** $5(m^2 - 2m - 1)$
b) $3(x^2 - 2x + 3)$ **d)** $(2x - 1)(3x + 5)$

6. $-8x^2 + 4x$; $4x$

7. **a)** $6x^2 + 24x + 24$ **c)** 6 is the common factor and $6 = 2 \times 3$.
b) yes

8. $x^2 + 3x - 10$; $(x - 2)(x + 5)$

9. **a)** $(x - 3)(x + 5)$ **c)** $(x - 7)(x - 5)$
b) $(n - 2)(n - 6)$ **d)** $2(a - 4)(a + 3)$

10. 4 does not divide evenly into 6.
11. Yes, because the positive factors of c that add to b can both be made negative so that they add to $-b$.

Lesson 2.4, pp. 109–110

1. a) $8x^2 + 14x + 3$; $(2x + 3)(4x + 1)$
   b) $3x^2 + x - 2$; $(3x - 2)(x + 1)$
2. a) $(2a - 1)$ c) $(x + 2)$
   b) $(5x - 2)$ d) $4(n - 3)$
3. $3x^2 + 16x + 5$; $(x + 5)(3x + 1)$
4. a) $(x - 4)(2x + 1)$ d) $2(x + 4)(x + 1)$
   b) $3(x + 1)(x + 5)$ e) $3(x - 3)(x + 7)$
   c) $(x + 3)(5x + 2)$ f) $(x - 7)(2x - 1)$
5. a) $(2x + 1)(4x + 3)$ d) $(3x - 2)(5x + 2)$
   b) $3(m - 1)(2m + 1)$ e) $2(n + 5)(3n - 2)$
   c) $(a - 4)(2a - 3)$ f) $2(4x + 3)(2x - 1)$
6. Answers may vary. E.g., $4x^2 - 8x - 5$; $4x^2 - 4x - 15$; $4x^2 - 25$
7. a) $k = 4, 3$ c) $k = 3, 6$
   b) $k = 18, 6, -6, -18, -39$
8. Yes. We want the product to be c and the sum to be b.
9. a) $(2x - 3)(3x + 4)$ d) $3n(n - 4)(4n - 9)$
   b) $(k + 5)(8k + 3)$ e) $3(k - 4)(k + 2)$
   c) $5(2r - 7)(3r + 2)$ f) $(4y - 5)(6y + 5)$
10. a) $(x + 3)(x + 2)$ d) $(a - 4)(a + 3)$
    b) $(x - 6)(x + 6)$ e) $4(x + 6)(x - 2)$
    c) $(5a + 2)(a - 3)$ f) $(2x - 3)(3x + 1)$
11. Yes. $n = 16, 24, 41, 49, \ldots$. The factors are $2(n + 1)(3n + 2)$.
    If either factor is a multiple of 25, the expression is a multiple of 50.
12. Once you have found the greatest common factor you can ask yourself what must you multiply the common factor by to get each term of the original polynomial. This helps you find the other factor.
    For $-4x^2 + 38x - 48$, the greatest common factor is -2.
    So the factors are $-2(2x^2 - 19x + 24)$. Now try to find two binomials that multiply to give the trinomial in the brackets,
    $-4x^2 + 38x - 48 = -2(2x - 3)(x - 8)$
13. a) $(2x + 3y)(3x + y)$ c) $(2x - 3y)(4x - y)$
    b) $(a - 2b)(5a + 3b)$ d) $4(a + 5)(3a - 2)$
14. No. If a and c are odd, their product is odd. So we look for a pair of odd numbers that multiply to ac and add to b. But two odd numbers add to an even number, so b is not odd.

Lesson 2.5, pp. 115–116

1. a) $4x^2 - 1$; $(2x + 1)(2x - 1)$
   b) $9x^2 + 6x + 1$; $(3x + 1)(3x + 1)$
2. a) $(x - 5)$ c) $(5a + 6)$ e) $(2m - 3)$
   b) $(n + 4)$ d) 7 f) $(3x + 1)$
3. a) $(x + 6)(x - 6)$ c) $(x + 8)(x - 8)$ e) $(x + 10)(x - 10)$
   b) $(x + 5)^2$ d) $(x - 12)^2$ f) $(x + 2)^2$
4. a) $(7a + 3)^2$ c) $-2(2x - 3)^2$ e) $4(2 - 3x)(2 + 3x)$
   b) $(x + 11)(x - 11)$ d) $20(a + 3)(a - 3)$ f) $(x + 3)^2$
5. a) 400 b) 580
6. a) 5 is not a perfect square.
   b) $b(-b)$ is not $+9$ and 5 is not a perfect square.
7. $(x - 3)(x - 2)(x + 2)(x + 3)$
8. 7, 5; −7, −5; −7, 5; 7, −5; 5, 1; −5, −1; 5, −1; −5, 1
9. $x^2 - (x - 2)^2 = 4(x - 1)$; average of x and $x - 2$ is $x - 1$

10. A perfect-square trinomial has two of the three terms perfect squares and the non-square term is 2 times the product of the square roots of the two square terms. A difference of squares polynomial has two perfect square terms separated by a minus sign.
11. a) $(10x + 3y)(10x - 3y)$ c) $(2x - y + 3)(2x - y - 3)$
    b) $(2x + y)^2$ d) $10(3x - 2y)^2$
12. a) $(2x - 5y - 2z)(2x - 5y + 2z)$
    b) $-(x - 16)(x + 2)$

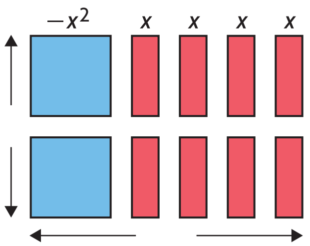
Chapter Review, pp. 120–121

1. a) $7x^2 + 11x - 9$ c) $-54x^2 + 63x - 10$
   b) $-144a^2 + 225$ d) $-20n^2 + 100n - 125$
2. $(4x - 1)(x + 4)$; $4x^2 + 15x - 4$
3. a) $(x - 2)$ c) $(b^2 - 2)$
   b) 3 d) $4x + 5$
4. a) $5x(2x - 1)$ c) $-2(x - 1)(x + 4)$
   b) $12(n^2 - 2n + 4)$ d) $(3a + 2)(5 - 7a)$
5. a) 2 by $3x^2 - 4$ b) No. $3x^2 - 4$ does not factor.
6. a) Answers may vary. E.g., $7x^2 - 7x$; $14x^2 - 21x$; $7x^3 + 21x^2 - 35x$
   b) $7x(x - 1)$; $7x(2x - 3)$; $7x(x^2 + 3x - 5)$
7. a) $6x - 2x^2 = 2x(3 - x)$
   b) $x^2 + 2x - 15 = (x - 3)(x + 5)$
8. a) $(x + 7)$ c) $(b + 4)$
   b) $(a - 4)$ d) $(x - 5)$
9. a) $(x + 5)(x + 2)$ c) $(x + 7)(x - 6)$
   b) $(x - 3)(x - 9)$ d) $(x - 10)(x + 9)$
10. Answers may vary. E.g.,
    $x^2 + 5x + 6 = (x + 2)(x + 3)$; $x^2 + 3x + 2 = (x + 1)(x + 2)$
11. a) $3x - 2x$ c) $6x - 56x$
    b) $24x - 15x$ d) $6x - 15x$
12. a) $(2x + 5)$ c) $(2b + 3)$
    b) $(a + 4)$ d) $(3x + 4)$
13. a) $(2x - 5)(3x - 2)$ c) $(4x - 3)(5x + 6)$
    b) $(2a - 3)(5a + 2)$ d) $(n + 1)(6n + 7)$
14. a) $9x^2 + 12x + 4$; $(3x + 2)(3x + 2)$
    b) $9x^2 - 4$; $(3x - 2)(3x + 2)$
15. a) $(x - 5)$ c) $(2b - 5)$
    b) $(3a + 1)$ d) $(3x - 8)$
16. a) $(2x + 3)(2x - 3)$ c) $(x - 2)(x + 2)(x^2 + 4)(x^4 + 16)$
    b) $(4a - 3)^2$ d) $(x + 1)^2$
17. $x^2 + 0x + 1$ cannot be factored as no numbers that multiply to $+1$ add to 0.
18. a) $(x + 5)(x - 3)$ d) $3(6x - 1)(x + 1)$
    b) $5(m + 4)(m - 1)$ e) $4(3x + 2)(3x + 2)$
    c) $2(x + 3)(x - 3)$ f) $5c^2(3c + 5)$
19. Factoring can be the opposite of expanding, for example:
    $(x + 1)(x + 2) = x^2 + 3x + 2$
    [factored] ⟷ [expanded]

Chapter Self-Test, p. 122

1. a) $-7x^2 + 2x$ c) $22x^2 - 105x + 119$
   b) $-200n^2 - 80n - 128$ d) $-78a^2 + 21a + 48$
2. $(3x - 3)(2x + 5)$; $6x^2 + 9x - 15$
3. a) $6x^2 - 7x - 3$ c) $12x^2 - 6x - 18$
   b) $4x - 6$ by $3x + 3$

4.



$-2x$ is the common factor. It divides into $-2x^2$, x times and into $8x$, -4 times. The factors are $-2x(x - 4)$.

5. **a)** $(x + 4)(x - 3)$ **c)** $-5(x - 8)(x - 7)$
b) $(a + 7)(a + 9)$ **d)** $(y - 6)(y + 9)$

6. **a)** $(x - 5)(2x + 1)$ **c)** $3(x - 2)(2x - 1)$
b) $(3n - 16)(4n - 1)$ **d)** $(4a + 3)(2a - 5)$

7. 3 by $4x^2 - x - 5$; $(3x + 3)$ by $(4x - 5)$; $(x + 1)$ by $(12x - 15)$

8. $m = 12, -12$

9. **a)** $(11x - 5)(11x + 5)$ **c)** $(x - 3)(x + 3)(x^2 + 9)$
b) $(6a - 5)^2$ **d)** $(n + 3)^2$

10. 7, 2; −7, −2; −7, 2; 7, −2; 9, 6; −9, −6; −9, 6; 9, −6; 23, 22; −23, −22; −23, 22; 23, −22

Chapter 3

Getting Started, pp. 126–128

1. **a)** (v) **c)** (iii) **e)** (ii)
b) (vi) **d)** (iv) **f)** (i)

2. **a)** $y = 6$ **c)** $a = \frac{9}{2}$
b) $x = \frac{16}{3}$ **d)** $c = \frac{7}{4}$

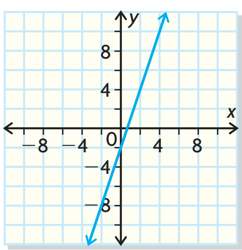
3. **a)** vertex: (0, 2); axis: $x = 0$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \geq 2\}$
b) vertex: (3, −5); axis: $x = 3$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \leq -5\}$

4. **a)** $5y - 5x$ **c)** $6x^4 + 10x^3$
b) $8m - 4$ **d)** $-x^2 - 2x + 12$

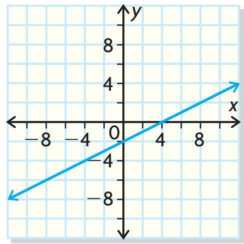
5. **a)** x-intercept: $\frac{7}{3}$; y-intercept: -7
b) x-intercept: 6; y-intercept: -2
c) x-intercept: 2; y-intercept: 5
d) x-intercept: 4; y-intercept: 3

6. **a)** $5(x^2 - x + 3)$ **d)** $(2x + 3)(3x - 1)$
b) $(x - 10)(x - 1)$ **e)** $2(x - 1)(x + 3)$
c) $(x + 5)(2x - 3)$ **f)** $(x - 11)(x + 11)$

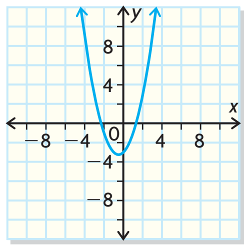
7. **a)**



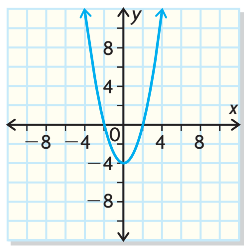
b)



c)



d)



8. **a)** x-intercepts: 3, −2; y-intercept: −6; min −6, the parabola opens up and $a > 0$
b) x-intercepts: 3, −3; y-intercept: 9; max 9, the parabola opens down and $a < 0$

9. **a)** linear, the graph shows a straight line or first difference is −1
b) nonlinear, the graph does not show a straight line or first difference is not constant

10.

Factoring atrategies:
Common factor to be done first
Difference of squares for 2 terms separated by a − sign
Simple trinomials for 3 terms starting with 1 or a prime number times x^2
Complex trinomials for 3 terms not starting with 1 or a prime number times x^2

Factoring Quadratics

Examples:	**Non-examples:**
$3x^2 + 6x + 9 = 3(x^2 + 2x + 3)$	$3x + 6$ is not quadratic
$4x^2 - 25 = (2x + 5)(2x - 5)$	$x^3 + 1$ is not quadratic
$x^2 + x - 20 = (x + 5)(x - 4)$	$x^2 + x + 1$ does not factor
$4x^2 + 16x + 15 = (2x + 3)(2x + 5)$	

Lesson 3.1, p. 131

1. Yes; it matches the minimum number of moves I found when I played the game, and when I substituted 6 into the model, I got 48.

2. Answers may vary. E.g.: R = red, B = blue, S = slide, J = jump

N															
1	RS	BJ	RS												
2	RS	BJ	BS	RJ	RJ	BS	BJ	RS							
3	RS	BJ	BS	RJ	RJ	RS	BJ	BJ	BJ	RS	RJ	RJ	BS	BJ	RS

It is very symmetric. Each row of the table starts and ends with a slide.

Answers

3. Yes; number of moves: 5, 11, 19, …; $f(x) = x^2 + 3x + 1$, when graphed it appears quadratic

Lesson 3.2, pp. 139–142

1. **a)** $-5, 3$ **b)** $f(x) = (x + 5)(x - 3)$

2. **a)** $f(x) = 2x(x + 6)$, zeros: $0, -6$; axis: $x = -3$; vertex: $(-3, -18)$

b) $f(x) = (x - 4)(x - 3)$, zeros: 4, 3; axis: $x = \frac{7}{2}$; vertex: $\left(\frac{7}{2}, -\frac{1}{4}\right)$

c) $f(x) = -(x + 10)(x - 10)$, zeros: $-10, 10$; axis: $x = 0$; vertex: $(0, 100)$

d) $f(x) = (x + 3)(2x - 1)$, zeros: $-3, \frac{1}{2}$; axis: $x = -\frac{5}{4}$; vertex: $\left(-\frac{5}{4}, -\frac{49}{8}\right)$

3. **a)** $f(x) = 3x^2 - 12x; 0$

b) $f(x) = x^2 + 2x - 35; -35$

c) $f(x) = 6x^2 - 20x - 16; -16$

d) $f(x) = 6x^2 + 7x - 20; -20$

4. **a)** zeros: $0, -6$; axis of symmetry: $x = -3$; vertex: $(-3, -18)$

b) zeros: $8, -4$; axis: $x = 2$; vertex: $(2, -36)$

c) zeros: 10, 2; axis: $x = 6$; vertex: $(6, 16)$

d) zeros: $-\frac{5}{2}, \frac{9}{2}$; axis: $x = 1$; vertex: $(1, 49)$

e) zeros: $-\frac{3}{2}, 2$; axis: $x = \frac{1}{4}$; vertex: $\left(\frac{1}{4}, -\frac{49}{8}\right)$

f) zeros: $5, -5$; axis $x = 0$; vertex: $(0, 25)$

5. **a)** $g(x) = 3x(x - 2)$; zeros: 0, 2; axis: $x = 1$; vertex: $(1, -3)$

b) $g(x) = (x + 3)(x + 7)$; zeros: $-7, -3$; axis: $x = -5$; vertex: $(-5, -4)$

c) $g(x) = (x + 2)(x - 3)$; zeros: $-2, 3$; axis: $x = \frac{1}{2}$; vertex: $\left(\frac{1}{2}, -6.25\right)$

d) $g(x) = 3(x - 1)(x + 5)$; zeros: $-5, 1$; axis: $x = -2$; vertex: $(-2, -27)$

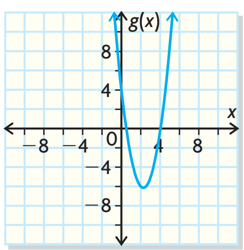
e) $g(x) = (x - 7)(2x + 1)$; zeros: $-\frac{1}{2}, 7$; axis: $x = 3.25$; vertex: $(3.25, -28.125)$

f) $g(x) = -6(x - 2)(x + 2)$; zeros: $-2, 2$; axis: $x = 0$; vertex: $(0, 24)$

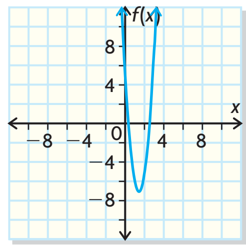
6. **a)** (iii) **c)** (iv) **e)** (v)
b) (ii) **d)** (i)
I expanded or graphed.

7. **a)** 20.25, max **c)** 45.125, max **e)** 25, max
b) -49, min **d)** -2.25, min **f)** -4, min

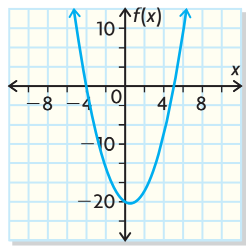
8. **a)**



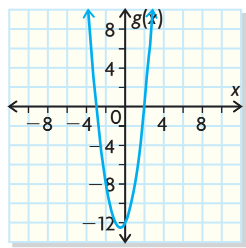
b)



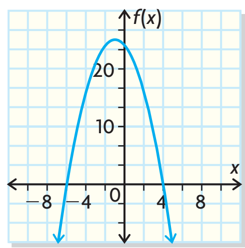
c)



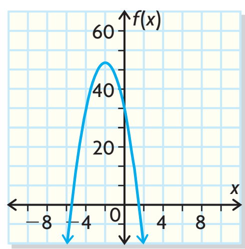
d)



e)



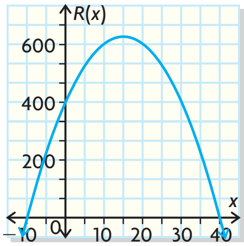
f)



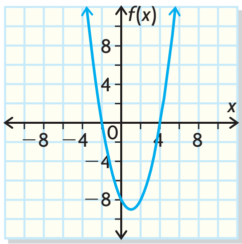
9. **a)** the y-intercept, the direction the parabola opens; in $f(x) = x^2 - x - 20$, the y-intercept is -20, and the parabola opens upward because a is $+1$, which is greater than 0

b) the x-intercept(s), the axis of symmetry, the direction the parabola opens; in $f(x) = (x - 5)(x + 7)$, the zeros are 5 and -7, the axis of symmetry is $x = -1$, and the parabola opens upward because a is $+1$, which is greater than 0

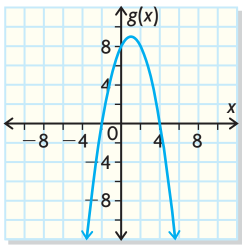
10. **a)** zeros: 40, -10; axis: $x = 15$; y-intercept: 400; vertex: (15, 625); max: 625



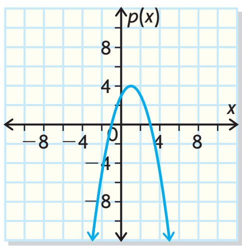
b) $f(x) = x^2 - 2x - 8$; zeros: 4, -2; axis: $x = 1$; y-intercept: -8; vertex: $(1, -9)$; min: -9



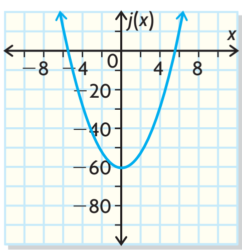
c) $f(x) = (4 - x)(x + 2)$; zeros: 4, -2; axis: $x = 1$; y-intercept: 8; vertex: (1, 9); max: 9



d) $p(x) = -x^2 + 2x + 3$; zeros: 3, -1; axis: $x = 1$; y-intercept: 3; vertex: (1, 4); max: 4



e) $j(x) = (2x - 11)(2x + 11)$; zeros: $\frac{11}{2}$, $-\frac{11}{2}$; axis: $x = 0$; y-intercept: -121; vertex: $(0, -121)$; min: -121



11. $h(t) = -5t(t - 3)$; 11.25 m

12. **a)** $f(x) = (x + 2)(x - 7)$; $f(x) = x^2 - 5x - 14$
b) $f(x) = (7 - x)(x + 5)$; $f(x) = -x^2 + 2x + 35$
c) $f(x) = \frac{1}{2}(x + 3)(x + 6)$; $f(x) = \frac{1}{2}x^2 + \frac{9}{2}x + 9$
d) $f(x) = -\frac{2}{9}x(x - 6) = -\frac{2x^2}{9} + \frac{4x}{3}$

13. **a)** $x = 5$; (5, 6); $f(x) = -\frac{2}{3}(x - 2)(x - 8)$;
$f(x) = -\frac{2}{3x^2} + \frac{20}{3x} - \frac{32}{3}$
b) $x = -\frac{9}{2}$; $\left(-\frac{9}{2}, -2\right)$; $f(x) = \frac{8}{25}(x + 7)(x + 2)$;
$f(x) = \frac{8}{25x^2} + \frac{72x}{25} + \frac{112}{25}$
c) $x = 4$; (4, 5); $f(x) = -\frac{1}{5}(x + 1)(x - 9)$;
$f(x) = -\frac{x^2}{5} + \frac{8x}{5} + \frac{9}{5}$
d) $x = -4$; $(-4, -5)$; $f(x) = \frac{5}{16x}(x + 8)$;
$f(x) = \frac{5}{16x^2} + \frac{5}{2x}$

14. **a)** $t = 7$ s
b) $t = 5$ s

15. 75 km/h

16. Find the zeros and then the axis of symmetry. Find the vertex and use all those points to graph the function.

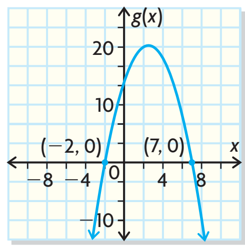
17. $y = \left(-\frac{1}{48}\right)x^2 + 192$

18. $h(t) = -t(4.9t - 30)$

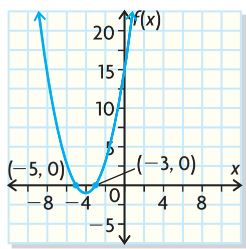
19. **a)** $h(d) = -0.0502(d - 21.9)(d + 1.2)$
b) r and s are the points where the shot is on the ground.

Lesson 3.3, pp. 149–152

1. **a)** zeros: -2, 7



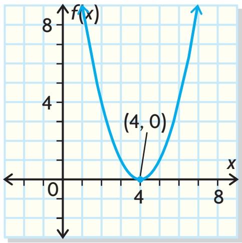
b) zeros: -3, -5



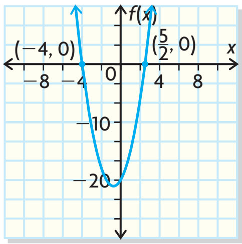
2. a) zeros: $-4, 5$ b) zeros: $-1.4, 6.4$

3. a) $x^2 - 2x - 35 = 0$; zeros: $-5, 7$
b) $-x^2 + 3x + 4 = 0$; zeros: $-1, 4$
c) $x^2 + 3x - 5 = 0$; zeros: $-4.2, 1.2$
d) $-6x^2 - x + 2 = 0$; zeros: $-\frac{2}{3}, \frac{1}{2}$

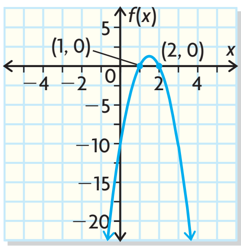
4. a) zero: 4



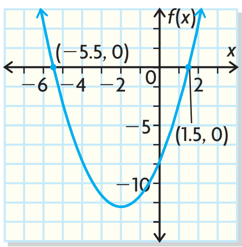
b) zeros: $-4, \frac{5}{2}$



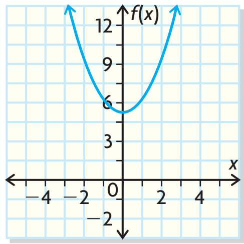
c) zeros: 1, 2



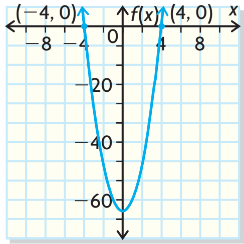
d) zeros: $-5.5, 1.5$



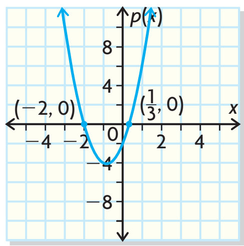
e) no solution



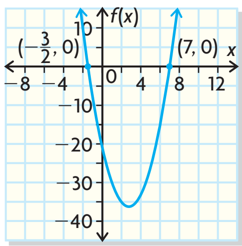
f) zeros: $-4, 4$



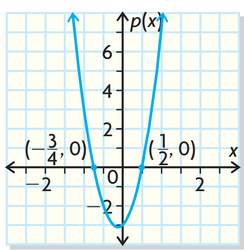
5. a) zeros: $-2.0, \frac{1}{3}$



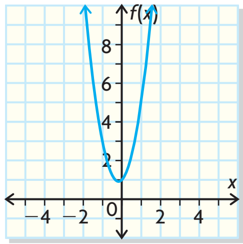
b) zeros: $-\frac{3}{2}, 7$



c) zeros: $-\frac{3}{4}, \frac{1}{2}$



d) no solution



6. **a)** 71 900 people **b)** partway through 2019
c) 1983

7. 26.9 s

8. 3.53 s

9. 2

10. **a)** $b = 5$ or $b = 2$, so to break even, the company must produce 5000 or 2000 skateboards
b) 3500

11. **a)** 45 m **b)** 4 s

12. **a)** 15 min **b)** $160

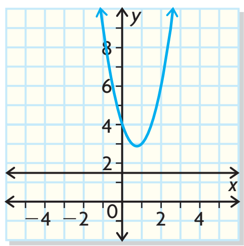
13. **a)** i) Answers may vary. E.g., $f(x) = 8x^2 + 2x - 3$
ii) Answers may vary. E.g., $f(x) = x^2 - 6x + 9$
iii) Answers may vary. E.g., $f(x) = x^2 + 2$
b) There can only be no zeros, one zero, or two zeros because a quadratic function either decreases and increases (or increases and decreases), so it will not be able to cross the x-axis a third time.

14. **a)** $f(x) = 3x^2 - 2x + 1$
b) Graph the function and find where the graph crosses the x-axis.

15. $y = -0.3x^2 + 150$

16. **a)** (1.5, 5) and (−2, −9)
b) (−1.5, −3.75) and (5, 6)

17. The graphs $y = 2x^2 - 3x + 4$ and $y = 1.5$ do not intersect.



Mid-Chapter Review, p. 155

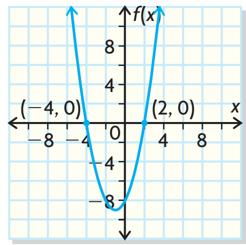
1. **a)** $f(x) = 2x^2 + 17x + 21$
b) $g(x) = -3x^2 + 16x + 12$
c) $f(x) = -8x^2 - 2x + 15$
d) $g(x) = -6x^2 + 13x - 5$

2. **a)** (ii) **c)** (i) **e)** (iii)
b) (i) **d)** (ii)

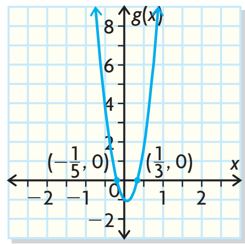
3. **a)** minimum −36 **c)** minimum −28.125
b) maximum 40.5 **d)** maximum 15.125

4. Answers may vary. E.g., Factored form is most useful because it gives the zeros, and the midpoint of the zeros gives the vertex. In $f(x) = (x - 2)(x - 6)$, the zeros are 2 and 6, and the vertex is (4, −4).

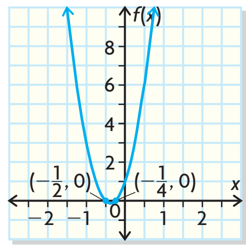
5. **a)** zeros: −4, 2



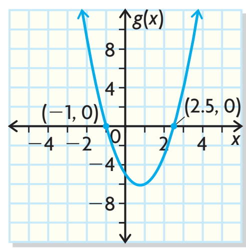
b) zeros: $\frac{1}{3}, -\frac{1}{5}$



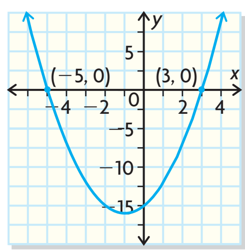
c) zeros: $-\frac{1}{4}, -\frac{1}{2}$



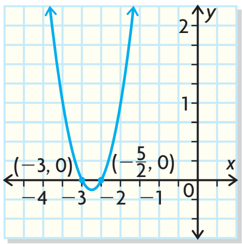
d) zeros: 2.5, −1



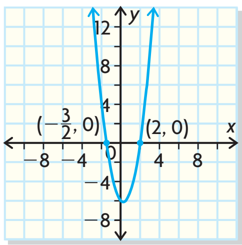
6. **a)** zeros: −5, 3



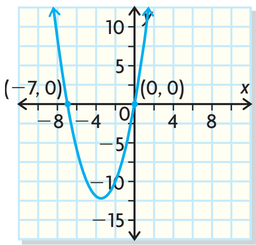
b) zeros: $-3, -\frac{5}{2}$



c) zeros: $2, -\frac{3}{2}$



d) zeros: $-3, -4$



7. It is a dangerous ball. It is above 1 m from $0.11 < t < 1.9$.

8. No. $(x - 3)(x + 4) = x^2 - x + 12$

Lesson 3.4, pp. 161–163

1. **a)** $x = -3, 5$ **b)** $x = 6, 9$ **c)** $x = -\frac{1}{2}, \frac{5}{3}$ **d)** $x = 0, 3$

2. **a)** $(x + 5)(x - 4); x = -5, 4$
b) $(x - 6)(x + 6), x = -6, 6$
c) $(x + 6)(x + 6); x = -6$
d) $x(x - 10); x = 0, 10$

3. **a)** yes **b)** no **c)** yes **d)** no

4. **a)** $x = -6, 9$ **b)** $x = 13, -13$ **c)** $x = -7$ **d)** $x = 14, 3$ **e)** $x = -\frac{1}{2}, 5$ **f)** $x = \frac{1}{3}, -4$

5. **a)** $x = 17, -17$ **b)** $x = \frac{5}{3}$ **c)** $x = -3, 5$ **d)** $x = -\frac{1}{2}, 7$ **e)** $x = -3, 5$ **f)** $x = -\frac{3}{2}, 5$

6. **a)** $x = -10, 0$ **b)** $x = -\frac{1}{3}, 0$ **c)** $x = -7, -2$ **d)** $x = -3, 9$ **e)** $x = 5, \frac{16}{3}$ **f)** $x = -\frac{5}{2}, -\frac{1}{3}$

7. **a)** $x = -6, 7$ **b)** $x = -4, 1$ **c)** $x = 4, -9$ **d)** $x = 2, \frac{8}{3}$ **e)** $x = -\frac{1}{4}, -\frac{3}{2}$ **f)** $x = \frac{3}{2}, -\frac{1}{5}$

8. 5 s

9. **a)** 0, 24 **b)** 288 m^2

10. **a)** at 0 and 6000 snowboards
b) when they sell between 0 and 6000 snowboards

11. $t = 3$ *s*

12. 9 s

13. $30 025

14. **a)** $P(x) = -5x^2 + 19x - 10$
b) between 631 and 3169 pairs of shorts

15. No. Some equations do not factor or are too difficult to factor.

16. It is faster and helps find the maximum or minimum value, but it can be difficult or impossible to factor the equation.

17. 14.1 s

18. $2 < t < 10$

Lesson 3.5, pp. 168–169

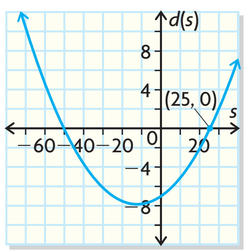
1. **a)** between 400 and 900 games
i) table of values

x	$P(x)$
3	−6
4	0
5	4
6	6
7	6
8	4
9	0

ii) factoring: $P(x) = -(x - 9)(x - 4)$

2. $-5(t - 10)(t + 1) = 0$; $t = 10$ or $t = -1$; the ball hits the ground after 10 s.

3. $0.0056s^2 + 0.14s = 7$; 0.5 km/h

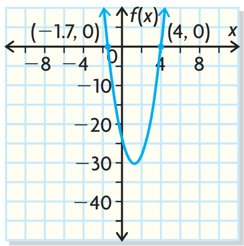


4. Beverly used an appropriate method, but she should have substituted 20 instead of 2020 because $t = 0$ corresponds to the year 2000 to get a population of 74 000.

5. Solution 1: Using a table of values
$x = 4$

x	y
−2	12
−1.5	0
−1	−10
0	−24
1	−30
2	−28
3	−18
4	0

Solution 2: Using a graph
$x = 4$ and $x = -1.5$

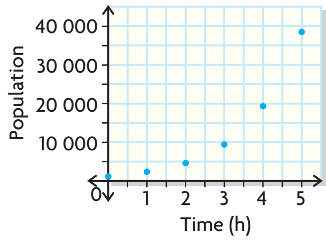


Solution 3: By factoring
$x = -\frac{3}{2}$ and $x = 4$
$2(2x + 3)(x - 4) = 0$

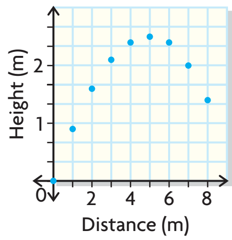
6. The population will be 312 000 in 2008 and 1972.
7. You can use graphing and factoring. Your answers will be $x = -3, 5$.
8. approximately 15.77 m
9. \$450 000
10. 1 s
11. a) Answers may vary. E.g., $16 = -2x^2 + 32x + 110$
$0 = -2x^2 + 32x - 126$
$0 = -2(x^2 + 16x - 63)$
$0 = -2(x + 7)(x - 9)$
$x = 7$ and $x = 9$
They must sell either 7000 or 9000 games.
b) Answers may vary. E.g., I let $P(x) = 16$ in the function, since P is profit in thousands of dollars. I rearranged the equation to get 0 on the left side, then factored the right side. I determined values for x where each of the factors were zero. These were the solutions to the equation. I multipled these numbers by 1000, since they represent the number of games in thousands.
12. She noticed that when $t = -30$ and 10, $P(t) = 35\ 000$. Since $t = 0$ corresponds to 2000, then $t = -30$ corresponds to 1970.
13. 5 and 5; product is 25
14. 6 m × 6 m

Lesson 3.6, pp. 176–179

1. a) $x = 3, x = -5; a = 2; y = 2(x - 3)(x + 5); y = 2x^2 + 4x - 30$
b) $x = 1.5, x = -3; a = -2; y = (-2x + 3)(x + 3);$
$y = -2x^2 - 3x + 9$
2. a) not quadratic because the graph does not have a maximum or minimum because the data does not increase and decrease or vice versa



b) quadratic, the graph looks parabolic



3. a) $y = 0.5(x - 2)(x + 1); y = 0.5x^2 - 0.5x - 1$
b) $y = -0.5(x + 2)(x - 3); y = -0.5x^2 + 0.5x + 3$
4. a) $y = -2x^2 + 2x + 24$
b) $y = x^2 + 7x + 10$
c) $y = 3x^2 + 6x - 105$
d) $y = -3x^2 + 18x - 24$
5. $h(x) = -0.37x^2 + 1.48x - 0.52$; 3.6 m
6. $h(t) = -5t^2 + 35, t = 2.45$ s
7. $h(t) = -4.9t^2 + 9.7t + 1, t = 1.7$ s, 0.2 s
8. $h(t) = -4.9t^2 + 17.9t + 0.5, t = 3.7$ s
9. a) $y = 0.21(x - 3)(x - 12)$
b) −4.25 m
10. a) $y = -x^2 + 7x + 50$
b) They will sell no more shoes in month 12.
11. a) 0, 0, 1, 3, 6, 10, 15
b) number of lines $= \frac{n(n-1)}{2}$, where n is the number of dots and $n \geq 2$
12. The zeros are a and b. So, $f(x) = k(x - a)(x - b)$. To determine k, use another point on the parabola.
13. $y = 0.000\ 36x^2 + 4$
14. a)

Time (s)	2.5	3.0	3.5	4.0	4.5	5.0	5.06
Height (m)	32.125	30.9	27.225	21.1	12.525	1.5	0

b) $y = -4.9t^2 + 24.5t + 1.5$
c) 32.125 m

Chapter Review, pp. 182–183

1. a) (ii) c) (iv)
b) (iii) d) (i)
2. a) min −36 b) min − 3.125 c) max 15.125
3. a) $x = -5$ or $x = 3$, min −16
b) $x = 7$ or $x = 1$, max 9
c) $x = -8$ or $x = -1$, min −24.5

Answers

d) $x = -\frac{1}{2}$ or $x = -3$, min -3.125

e) $x = -\frac{3}{2}$ or $x = \frac{1}{3}$, min $-\frac{121}{24}$

f) $x = -7$ or $x = 7$, max 49

4. a) 3.15 m b) 2.38 s

5. a) zeros: -3, 5; vertex: (1, 32); y-int: 30

b) zeros: 4, -2; vertex: $(1, -18)$; y-int: -16

6. a) $x = -7$ or $x = 5$

b) $x = 3$ or $x = -8$

c) $x = \frac{1}{3}$

d) $x = -\frac{1}{2}$ or $x = \frac{5}{3}$

7. $t = 1$ and 9 s

8. a) 2014 b) 87 850 people

9. $x = 2$; No, you cannot just change the 17 to be positive. The answer should be $x = 2$.

10. a) $y = -4.9x^2 + 37.6x + 14$

b) It is close to most of the points on the graph.

11. $y = -3(x + 2)(x - 4)$ or $y = -3x^2 + 6x + 24$

Chapter Self-Test, p. 184

1. a) $f(x) = 6x^2 - 37x + 45$

b) $f(x) = -5x^2 - 4x + 12$

2. a) $f(x) = (x - 9)(x + 9)$

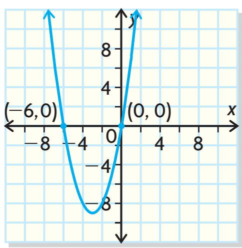
b) $f(x) = (2x - 1)(3x + 4)$

3. a) $x = 5, -7$; $x = -1$; minimum -36

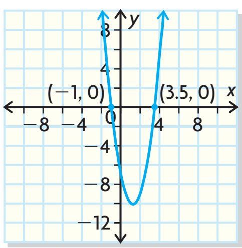
b) $x = \frac{1}{2}, -\frac{7}{2}$; $x = -1.5$; maximum 16

4. No. Some may not factor at all, while for others it may not be as obvious what the factors are.

5. a) $x = 0$ and $x = -6$



b) $x = -1$ and $x = 3.5$



6. a) $x = -6$ and $x = \frac{1}{2}$

b) $x = -3$ and $x = 7$

7. a) 2015

b) 11 700 people

8. a) 6.4 s

b) 57 m

9. a) $y = -343x^2 + 965x - 243$

b) It is close to most of the data points.

c) 36491 kg/ha

10. It makes it easier to answer questions about the data.

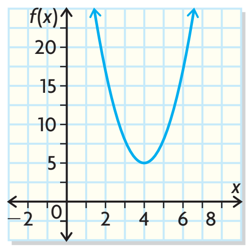
Cumulative Review Chapters 1–3, pp. 186–189

1. (a)	**5.** (c)	**9.** (d)	**13.** (c)	**17.** (a)
2. (c)	**6.** (b)	**10.** (b)	**14.** (a)	**18.** (b)
3. (a)	**7.** (d)	**11.** (d)	**15.** (c)	
4. (d)	**8.** (c)	**12.** (c)	**16.** (c)	

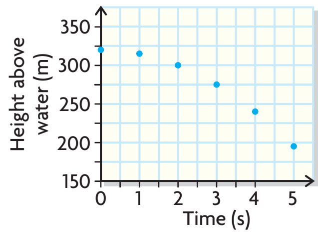
19. a) Domain $\{x \in \mathbf{R}\}$, Range $\{y \in \mathbf{R} \mid y \geq 4\}$

b) Transformations: vertical stretch by a factor of 3, horizontal translation 4 to the right, vertical translation 5 up

c)



20. a)

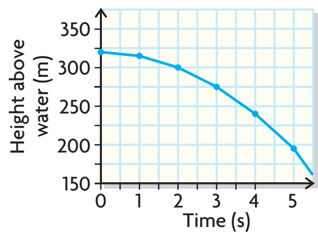


b) quadratic; the graph appears to have a shape of part of a parabola. The second differences are also constant.

c)

***t*(*s*)**	6	7	8
***h*(*m*)**	140	75	0

d)



e) vertex: (0, 320); axis: $x = 0$; zeros: $x = 8$ and $x = -8$
$h(t) = -5(t - 8)(t + 8)$ or $h(t) = -5t^2 + 320$

f) domain $\{t \in \mathbf{R} \mid 0 \leq t \leq 8\}$;
range $\{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 320\}$

g) i) 38.75 m ii) 7.35 s

Chapter 4

Getting Started, pp. 192–194

1. **a)** (iv) **b)** (iii) **c)** (v) **d)** (ii) **e)** (i) **f)** (vi)

2. **a)** $(x + 10)(x - 3)$; $x = -10$ or $x = 3$
b) $(x + 5)(x + 3)$; $x = -5$ or $x = -3$
c) $(x + 2)(x - 3)$; $x = -2$ or $x = 3$
d) $(x - 2)(x - 3)$; $x = 2$ or $x = 3$

3. **a)** $(x + 3)^2$ **b)** $(x - 4)^2$ **c)** $(3x + 1)^2$ **d)** $(2x - 3)^2$

4. **a)** $-15x^2 + 7x + 8$ **b)** $2x^2 + 6$ **c)** $12x^2 - x - 35$ **d)** $4x^2 - 1$

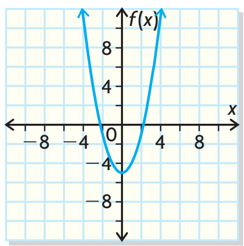
5. **a)** $(x - 5)(x + 8)$ **b)** $(2x + 3)(3x - 2)$ **c)** $(9x - 7)(9x + 7)$ **d)** $(3x + 1)^2$

6. **a)** 9 **b)** $10x$ **c)** $28x$ **d)** 16

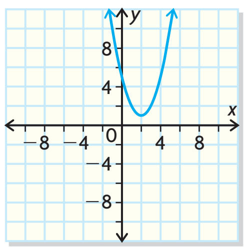
7. **a)** $f(x) = (x - 9)(x + 2)$ **b)** $g(x) = -(x - 8)(2x - 1)$ **c)** $h(x) = (2x - 5)(2x + 5)$ **d)** $y = (3x - 1)(2x + 5)$

8. **a)** vertex: $(-3, -4)$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \geq -4\}$
b) vertex: $\left(\frac{5}{4}, -\frac{121}{8}\right)$; domain: $\{x \in \mathbf{R}\}$; range: $\left\{y \in \mathbf{R} \mid y \geq -\frac{121}{8}\right\}$
c) vertex: $\left(-\frac{7}{12}, \frac{121}{24}\right)$; $\{x \in \mathbf{R}\}$; range: $\left\{y \in \mathbf{R} \mid y \leq \frac{121}{24}\right\}$
d) vertex: $\left(\frac{3}{2}, \frac{147}{4}\right)$; $\{x \in \mathbf{R}\}$; range: $\left\{y \in \mathbf{R} \mid y \leq \frac{147}{4}\right\}$

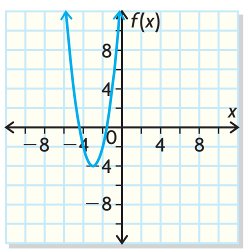
9. **a)** $f(x) = x^2$ vertically shifted down 5 units



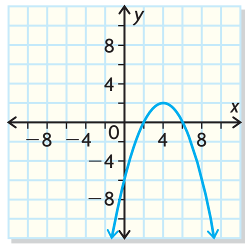
b) $f(x) = x^2$ translated 2 units right and 1 unit up



c) $f(x) = x^2$ translated 3 units left, stretched vertically by a factor of 2 and translated 4 units down



d) $f(x) = x^2$ translated 4 units right, compressed vertically by a factor of 2, reflected in the x-axis and translated 2 units up



10. 0.5 s

11.

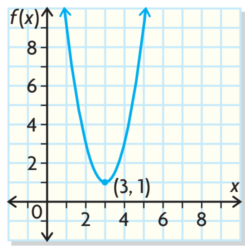
Essential characteristics:	Non-essential characteristics:
A polynomial equation containing one variable with highest degree 2.	Does not have to = 0. Can have fractional or decimal coefficients. Can have variables on both sides of the = sign. Does not have a solution.
Quadratic Equation	
Examples:	**Non-examples:**
$x^2 - 9 = 0$; $x^2 + 4x - 21 = 0$; $(3x - 1)(2x + 5) = 0$	$x^2 + x^2 = 0$; $x^2 + \frac{1}{x} = 0$

Lesson 4.1, pp. 203–205

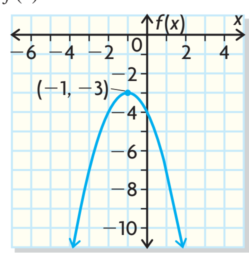
1. **a)** $(3, -5)$; min **b)** $(5, -1)$; max **c)** $(-1, 6)$; max **d)** $(-5, -3)$; min

2. **a)** $x = 3$, domain: $\{x \geq \mathbf{R}\}$; range: $\{y \geq \mathbf{R} \mid y \geq -5\}$
b) $x = 5$, $\{x \geq \mathbf{R}\}$; range: $\{y \geq \mathbf{R} \mid y < -1\}$
c) $x = -1$, $\{x \geq \mathbf{R}\}$; range: $\{y \geq \mathbf{R} \mid y < 6\}$
d) $x = -5$, $\{x \geq \mathbf{R}\}$; range: $\{y \geq \mathbf{R} \mid y \geq -3\}$

3. **a)** $f(x) = 2x^2 - 12x + 19$



b) $f(x) = -x^2 - 2x - 4$

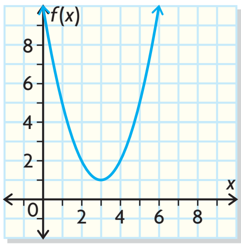


4.

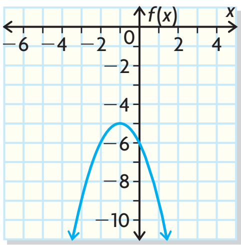
	Function	Vertex	Axis of Symmetry	Opens Up/Down	Range
a)	$f(x) = (x - 3)^2 + 1$	$(3, 1)$	$x = 3$	up	$y \geq 1$
b)	$f(x) = -(x + 1)^2 - 5$	$(-1, -5)$	$x = -1$	down	$y \leq -5$
c)	$y = 4(x + 2)^2 - 3$	$(-2, -3)$	$x = -2$	up	$y \geq -3$
d)	$y = -3(x + 5)^2 + 2$	$(-5, 2)$	$x = -5$	down	$y \leq 2$
e)	$f(x) = -2(x - 4)^2 + 1$	$(4, 1)$	$x = 4$	down	$y \leq 1$
f)	$y = \frac{1}{2}(x - 4)^2 + 3$	$(4, 3)$	$x = 4$	up	$y \geq 3$

Sketches (from table above)

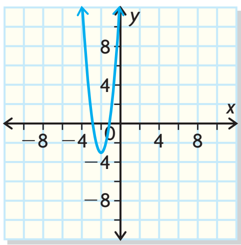
a)



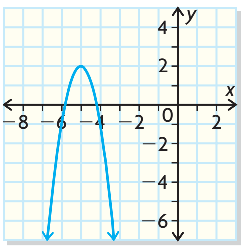
b)



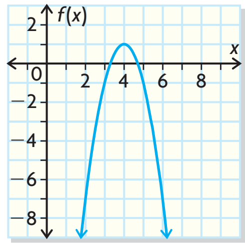
c)



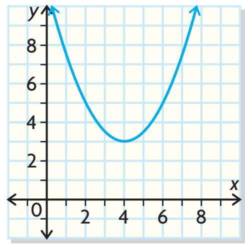
d)



e)



f)



5. **a)** $x = -8, 14$
b) $x = -12, 2$
c) $x = 1$
d) $x = -6.873$ or -0.873
e) $x = 0.192$ or 7.808
f) no zeros

6. $f(x) = (x - 7)^2 - 25$; vertex form: vertex $(7, -25)$; axis: $x = 7$; direction of opening: up
$f(x) = x^2 - 14x + 24$; standard form: y intercept is 24; direction of opening: up
$f(x) = (x - 12)(x - 2)$; factored form: zeros: $x = 12$ and $x = 2$; direction of opening: up

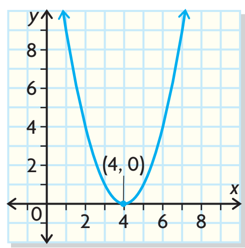
7. **a)** after 0.3 s; maximum since $a < 0$ so the parabola opens down
b) 110 m
c) 109.55 m

8. **a)** $y = -3(x + 4)^2 + 8$, $y = -3x^2 - 24x - 40$
b) $y = -(x - 3)^2 + 5$, $y = -x^2 + 6x - 4$
c) $f(x) = 4(x - 1)^2 - 7$, $y = 4x^2 - 8x - 3$
d) $y = (x + 6)^2 - 5$, $y = x^2 + 12x + 31$

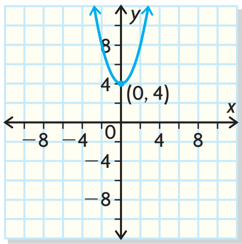
9. **a)** $f(x) = (x + 3)^2 - 4$
b) $f(x) = (x - 2)^2 + 1$
c) $f(x) = -(x - 4)^2 - 2$
d) $f(x) = -(x + 1)^2 + 4$

10. **a)** 23 m **b)** 2 s **c)** 1 s or 3 s

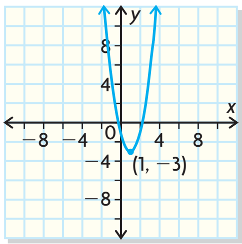
11. **a)** vertex: $(4, 0)$; two possible points $(3, 1)$, $(5, 1)$



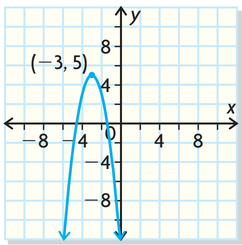
b) vertex: (0, 4); two possible points: (2, 8), (−2, 8)



c) vertex: (1, −3); two possible points: (−1, 5), (3, 5)



d) vertex: (−3, 5); two possible points: (−2, 3), (−4, 3)



12. $y = 2(x + 1)^2 - 8$

13. Expand and simplify. For example,

$$f(x) = (x + 2)^2 - 4$$
$$= x^2 + 4x + 4 - 4$$
$$= x^2 + 4x$$

14. **a)** y-intercept, opens upward or downward
b) vertex, opens upward or downward, max/min

15. $y = -0.88(x - 1996)^2 + 8.6$

16. $f(x) = (x - 1)^2 - 36$

Lesson 4.2, pp. 213–215

1. **a)** 16 **b)** 36 **c)** 25 **d)** $\frac{25}{4}$

2. **a)** $m = 10, n = 25$ **c)** $m = 12, n = 36$
b) $m = 6, n = 9$ **d)** $m = \frac{7}{2}, n = \frac{49}{4}$

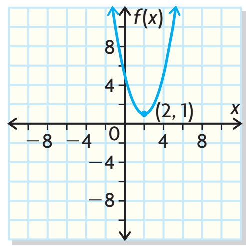
3. **a)** $(x + 7)^2$ **c)** $(x - 10)^2$
b) $(x - 9)^2$ **d)** $(x + 3)^2$

4. **a)** $(x + 6)^2 + 4$ **c)** $(x - 5)^2 + 4$
b) $(x - 3)^2 - 7$ **d)** $\left(x - \frac{1}{2}\right)^2 - \frac{13}{4}$

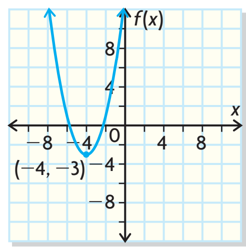
5. **a)** $a = 3, h = 2, k = 5$
b) $a = -2, h = -5, k = -3$
c) $a = 2, h = 3, k = 5$
d) $a = \frac{1}{2}, h = -3, k = -5$

6. **a)** $f(x) = (x + 4)^2 - 13$ **d)** $f(x) = -(x - 3)^2 + 16$
b) $f(x) = (x - 6)^2 - 1$ **e)** $f(x) = -\left(x - \frac{3}{2}\right)^2 + \frac{1}{4}$
c) $f(x) = 2(x + 3)^2 - 11$ **f)** $f(x) = 2\left(x + \frac{3}{4}\right)^2 - \frac{1}{8}$

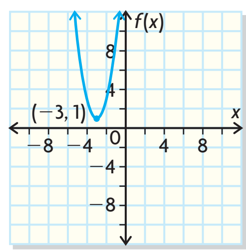
7. **a)** $f(x) = (x - 2)^2 + 1$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \geq 1\}$



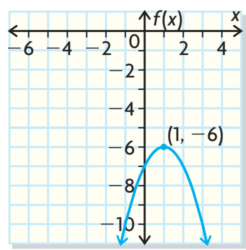
b) $f(x) = (x + 4)^2 - 3$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \geq -3\}$



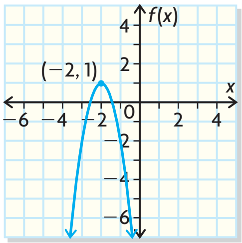
c) $f(x) = 2(x + 3)^2 + 1$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \geq 1\}$



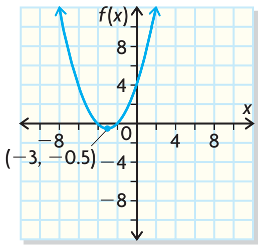
d) $f(x) = -(x - 1)^2 - 6$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \leq -6\}$



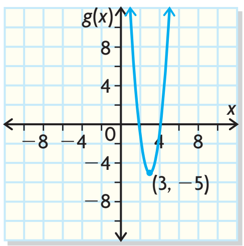
e) $f(x) = -3(x + 2)^2 + 1$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \leq 1\}$



f) $f(x) = \frac{1}{2}(x + 3)^2 - \frac{1}{2}$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \geq -0.5\}$



8. **a)** $g(x) = 4(x - 3)^2 - 5$
b) $x = 3$
c) $(3, -5)$
d) minimum value of -5 because $a > 0$; parabola opens up
e) domain: $\{x \in \mathbf{R}\}$
f) $\{g(x) \in \mathbf{R} \mid g(x) \geq -5\}$
g)



9. Colin should have taken the square root of both 9 and 4 to get $\frac{3}{2}$, not $\frac{3}{4}$.
10. 61 250 m^2
11. \$15
12. **a)** $y = 3(x - 5)^2 - 2$
b) vertex, axis of symmetry, max/min
13. Reflection about the x-axis, a vertical stretch of 2, a horizontal shift of 4, a vertical shift of 3. I completed the square to determine the vertex.
14. Each form provides different information directly.
15.
$$\begin{aligned} f(x) &= ax^2 + bx + c \\ &= x^2 + bx + c \\ &= x^2 + bx + \left(\frac{b}{2}\right)^2 - \left(\frac{b}{2}\right)^2 + c \\ &= \left(x + \frac{b}{2}\right)^2 + \left(c - \frac{b}{2}\right)^2 \end{aligned}$$

Example:
$$\begin{aligned} f(x) &= x^2 + 6x + 4 \\ &= x^2 + 6x + \left(\frac{6}{2}\right)^2 - \left(\frac{6}{2}\right)^2 + 4 \\ &= x^2 + 6x + 9 - (9 + 4) \\ &= (x + 3)^2 - 5 \end{aligned}$$

16. $y = -5(x - 1)^2 + 6$
17. $(1, 6)$

Lesson 4.3, pp. 222–223

1. **a)** $a = 3, b = -5, c = 2$ **c)** $a = 16, b = 24, c = 9$
b) $a = 5, b = -3, c = 7$ **d)** $a = 2, b = -10, c = 7$

2. **a)** **a)** $x = \dfrac{-(-5) \pm \sqrt{(-5)^2 - 4(3)(2)}}{2(3)}$

b) $x = \dfrac{-(-3) \pm \sqrt{(-3)^2 - 4(5)(7)}}{2(5)}$

c) $x = \dfrac{-(24) \pm \sqrt{(24)^2 - 4(16)(9)}}{2(16)}$

d) $x = \dfrac{-(-10) \pm \sqrt{(-10)^2 - 4(2)(7)}}{2(2)}$

b) **a)** $x = 1$ or $x = \frac{2}{3}$ **c)** $x = -\frac{3}{4}$
b) no solution **d)** $x = 4.16$ or $x = 0.84$

3. **a)** no solution
b) $x = -5$ or $x = 1.5$
c) $x = 5.5$
d) $x = -0.84$ or $x = 2.09$
e) no solution
f) $x = -0.28$ or $x = 0.90$

4. **a)** no solution
b) $x = -5$ or $x = 1.5$
c) $x = 5.5$
d) $x = -0.84$ or $x = 2.09$
e) no solution
f) $x = -0.28$ or $x = 0.90$

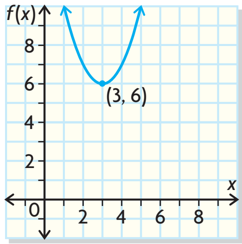
5. For example:
a) factoring, $x = 0$ or $x = 15$
b) take the square root of both sides, $x = -10.72$ or $x = 10.72$
c) factoring, $x = 8$ or $x = \frac{3}{2}$
d) expand, then use quadratic formula, $x = 2.31$ or $x = 11.69$
e) isolate the squared term, $x = -2$ or $x = 8$
f) quadratic formula, $x = 0.09$ or $x = 17.71$

6. **a)** 10.9 s **b)** approx. 9 s
7. 20 m × 20 m and 10 m × 40 m
8. 9.02 s
9. 91 km/h
10. Answers may vary. E.g., 2 solutions $2x^2 - 4x = 0$, $3x^2 - 4x - 2 = 0$; 1 solution $3x^2 - 6x + 3 = 0$, $x^2 - 2x + 1 = 0$; 0 solutions $x^2 - 6x + 10 = 0$
11. **a)** $x = 1.62$ or $x = 6.38$
b) $x = 1.62$ or $x = 6.38$
c) The method in part (a) was best because it required fewer steps to find the roots.
12. $(-1, -2)$ and $(3, 6)$
13. $(-1.21, -5.96)$ and $(2.21, 4.29)$
14. **a)** $x = 0$ and $x = 0.37$
b) $x = -3$ and $x = -2.4$, and $x = 2.4$ and $x = 3$

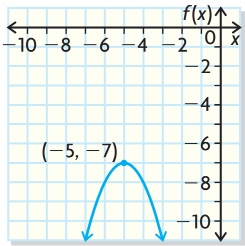
Mid-Chapter Review, p. 226

1. **a)** $f(x) = x^2 - 16x + 68$
b) $g(x) = -x^2 + 6x - 17$
c) $f(x) = 4x^2 - 40x + 109$
d) $g(x) = -0.5x^2 + 4x - 6$

2. **a)** vertex: $(3, 6)$; axis: $x = 3$; min. 6; domain: $\{x \in \mathbf{R}\}$;
range: $\{y \in \mathbf{R} \mid y \geq 6\}$



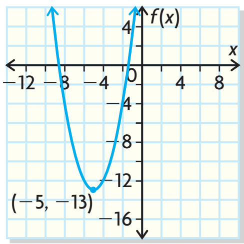
b) vertex: $(-5, -7)$; axis: $x = -5$; max. -7; domain: $\{x \in \mathbf{R}\}$;
range: $\{y \in \mathbf{R} \mid y \leq -7\}$



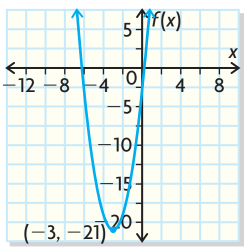
3. Answers may vary. E.g., the vertex form. From this form, I know the location of the vertex, which helps me sketch the graph. If $f(x) = (x + 2)^2 - 5$, then the vertex is $(-2, -5)$ and the parabola opens up.

4. **a)** $f(x) = 2(x - 2)^2 + 5$
b) $f(x) = -3(x + 1)^2 - 4$

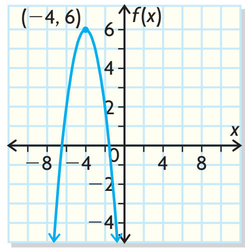
5. **a)** $f(x) = (x + 5)^2 - 13$



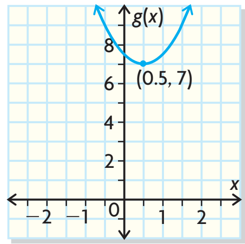
b) $f(x) = 2(x + 3)^2 - 21$



c) $f(x) = -(x + 4)^2 + 6$



d) $g(x) = 2(x - 0.5)^2 + 7$



6. \$205

7. 10 000 m^2

8. **a)** $x = -5, x = 3$ **c)** $x = 5.27, x = 8.73$
b) $x = \frac{1}{3}$ **d)** no solution

9. about 4 s

10. \$1.67 and \$10

11. **a)** 62 m **b)** about 8 s **c)** at 3 s and 5 s

Lesson 4.4, pp. 232–233

1. **a)** $(-5)^2 - 4(1)(7)$ **c)** $(12)^2 - 4(3)(-7)$
b) $(11)^2 - 4(-5)(17)$ **d)** $(1)^2 - 4(2)(-11)$

2. **a)** two distinct **c)** one **e)** two distinct
b) none **d)** none **f)** one

3. No, there are two solutions; $b^2 - 4ac = (-5)^2 - 4(1)(2) > 0$

4. **a)** two **c)** one **e)** none
b) none **d)** two **f)** one

5. $k > 4$ or $k < -4$

6. $m = 4$

7. $k < \frac{1}{2}, k = \frac{1}{2}, k > \frac{1}{2}$

8. **a)** Put a, b, and c into the discriminant and set the discrimant equal to zero. Solve for k.
b) $(-5)^2 - 4(3)(k) = 0, k = \frac{25}{12}$

9. $k = -4, k = 8$

10. **a)** $-50 < k < 50$
b) $k = \pm 50$
c) $k < -50, k > 50$

11. Answers may vary. E.g., if $a = 2$, $b = 3$, and $c = -1$, then $0 = 2x^2 + 3x - 1$. In this case, the discriminant $(b^2 - 4ac)$ has a value of 17, so there are 2 solutions.

12. Yes. The discriminant will be greater than zero. $x = 99.9$

13. Answers may vary. E.g., discriminant, quadratic formula

14. Yes. Set the expression equal to each other and solve. You would get $p = 1$ or $p = -13$.

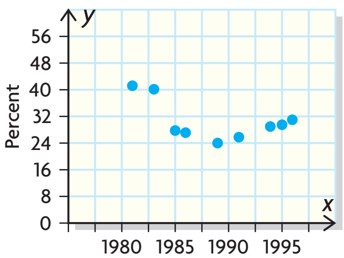
15. two distinct zeros for all values of k

Lesson 4.5, pp. 239–241

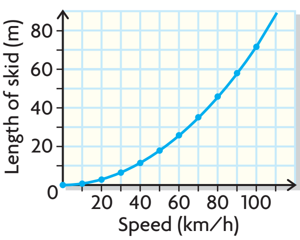
1. Complete the square to put the function in vertex form. The y-coordinate of the vertex will be the maximum revenue.
2. \$3025
3. Solve the equation $-4.9t^2 + 1.5t + 17 = 5$ for $t > 0$.
4. 1.73 s
5. \$1865; \$6
6. **a)** 8600
b) approx. 2011
c) no; the graph does not cross the horizontal axis
7. when selling between 1000 and 7000 pairs of shoes
8. 128 m^2
9. **a)** 8.4 m
b) 20 km/h
10. 2 m
11. 2017
12. **a)** \$6.50 **b)** \$8.00
13. **a)** about 1.39 m
b) 23 m
c) no, the ball hits the ground at 4.3 s
d) $t = 0.47$ s and $t = 3.73$ s
14. **a)** $f(x) = -60(x - 5.5)^2 + 1500$
b) \$2 or \$9
15. An advantage of the vertex form is that is provides the minimum or maximum values of the function. A disadvantage is that you must expand and simplify to find the zeros of the function using the quadratic formula.
16. 5 cm × 12 cm
17. 10 cm

Lesson 4.6, pp. 250–252

1. **a)** no, the graph increases too quickly
b) yes, the graph decreases and increases
2. **a)**



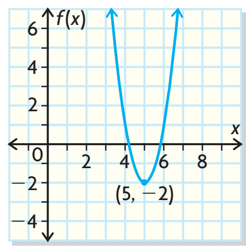
b) (1989, 23.5)
c) up, e.g., $a = 1$
d) e.g., needs to be wider so use a smaller, positive value for a
e) $y = 0.23(x - 1989)^2 + 23.5$, or
$y = 0.23x^2 - 912.53x + 908\,060.52$
f) domain: $\{x \in \mathbf{R} \mid 1981 \le x \le 1996\}$;
range: $\{y \in \mathbf{R} \mid 23.5 \le y \le 41.7\}$
3. **a)** $y = (x - 5)^2 - 3$
b) $y = -0.5(x + 4)^2 + 6$
4. **a)** $y = 2x^2 - 8x + 11$
b) $y = -2x^2 - 4x + 3$
c) $y = -4x^2 + 24x - 43$
d) $y = 6x^2 + 24x + 19$
5. **a)**



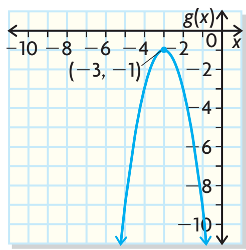
b) $y = 0.007x^2 - 0.0005x - 0.016$
c) Skid will be 100.7 m.
d) domain: $\{x \in \mathbf{R} \mid x \ge 0\}$; range: $\{y \in \mathbf{R} \mid y \ge 0\}$
6. **a)** $y = 0.000\,83x^2 - 0.116x + 21.1$
b) 21.1¢
c) domain: $\{x \in \mathbf{R} \mid x \ge 0\}$; range: $\{y \in \mathbf{R} \mid y \ge 17\}$
7. **a)** $y = -15(x - 1987)^2 + 1075$
b) not very well, because they would be selling negative cars
c) domain: $\{x \in \mathbf{R} \mid x \ge 1982\}$; range: $\{y \in \mathbf{R} \mid y \le 1075\}$
8. $y = -5(x - 2)^2 + 20.5$; $x \ge 0$, $y \ge 0$; 4 s
9. **a)** $y = -0.53x^2 + 1.39x + 0.13$
b) domain: $\{x \in \mathbf{R} \mid x \ge 0\}$; range: $\{y \in \mathbf{R} \mid y \le 1.1\}$
c) 0.57 kg/ha or 2.05 kg/ha
10. **a)** $y = 0.03(x - 90)^2 + 16$
b) 1096 mph, no a regular car can't drive that fast!
11. $f(x) = 2x^2 + 4x + 6$
12. If the zeros of the function can be determined, use the factored form $f(x) = a(x - r)(x - s)$. If not, then use graphing technology and quadratic regression.
13. 12.73 m
14. 15, 24
15. \$6250, \$12.50

Chapter Review, pp. 254–255

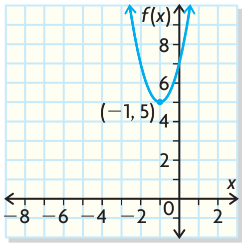
1. **a)** $f(x) = x^2 + 6x + 2$
b) $f(x) = -x^2 - 14x - 46$
c) $f(x) = 2x^2 - 4x + 7$
d) $f(x) = -3x^2 + 12x - 16$
2. **a)** $y = (x - 3)^2 - 5$
b) $f(x) = -(x - 6)^2 + 4$
c) $f(x) = \frac{1}{2}(x + 2)^2 - 3$
d) $f(x) = 2(x - 5)^2 + 3$
3. **a)** $f(x) = (x + 1)^2 - 16$
b) $f(x) = -(x - 4)^2 + 9$
c) $f(x) = 2(x + 5)^2 - 34$
d) $f(x) = 3(x + 2)^2 + 7$
e) $f(x) = \frac{1}{2}(x - 6)^2 + 8$
f) $f(x) = 2\left(x + \frac{1}{2}\right)^2 + \frac{7}{2}$
4. **a)** vertex: $(5, -2)$; axis: $x = 5$; opens up because $a > 0$; two zeros because the vertex is below the x-axis; parabola opens up



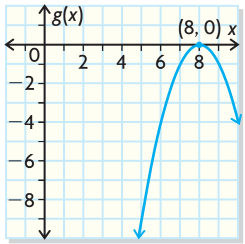
b) vertex: $(-3, -1)$; axis: $x = -3$; opens down because $a < 0$; no zeros because the vertex is below the x-axis; parabola opens down



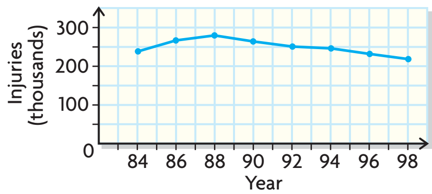
c) vertex: $(-1, 5)$; axis: $x = -1$; will have no zeros because the vertex is above the x-axis; parabola opens up



d) vertex: $(8, 0)$; axis: $x = 8$; $a < 0$, will have one zero because the vertex is on the x-axis; parabola opens down



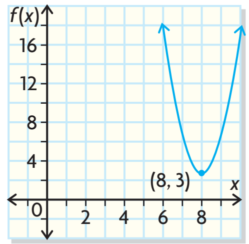
5. a) $x = -\frac{1}{2}, x = 8$
   b) no solution
   c) $x = \frac{1}{3}$
   d) $x = 1.16, x = -2.40$
6. a) 2.7 m b) 1.5 s
7. a) no solution
   b) two distinct solutions
   c) one solution
8. a) $\frac{16}{5} > k$ b) $\frac{16}{5} = k$ c) $\frac{16}{5} < k$
9. a) 25 cars b) $525
10. a) $41\ 472\ m^2$ b) $10\ 720\ m^2$ c) 36 m
11. a) $y = -4.9(x - 1.5)^2 + 10.5$
    b) domain: $\{x \in \mathbf{R} \mid 0 \le x \le 2.96\}$;
    range: $\{y \in \mathbf{R} \mid 0 \le y \le 10.5\}$
    c) 2.8 s
12. a)



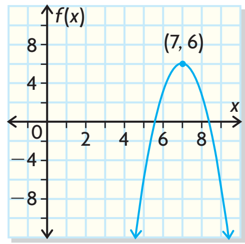
b) $y = -673.86x^2 + 2\ 680\ 816x - 2\ 665\ 999\ 342$
c) Use the quadratic regression function on a graphing calculator to determine the curve's equation. $y = -673.86x^2 + 2\ 680\ 816x - 2\ 665\ 999\ 342$
d) 160 715, using the above equation
e) 1989

Chapter Self-Test, p. 256

1. a) $f(x) = x^2 + 6x + 2$
   b) $f(x) = -3x^2 - 30x - 73$
2. a) $f(x) = (x - 5)^2 + 8$
   b) $f(x) = -5(x - 2)^2 + 8$
3. a) vertex: $(8, 3)$; axis: $x = 8$; min. 3



b) vertex: $(7, 6)$; axis: $x = 7$; max. 6



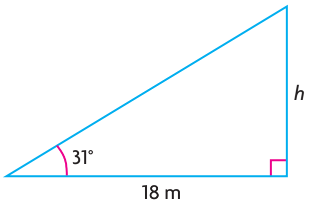
4. If you get a negative under the square root, you cannot solve. There are no solutions to these equations.
5. a) $x = -1.12, x = 7.12$
   b) no solution
6. a) no solution b) one solution
7. a) 20.1m b) 15.2 m
8. a) $13 812 b) $24
9. a) $y = -1182(x - 2)^2 + 4180$
   b) It fits the data pretty well.
   c) domain: $\{x \in \mathbf{R} \mid x \ge 0\}$; range: $\{y \in \mathbf{R} \mid y \le 4180\}$
   d) $4106
10. It is easier to use this method to find the max/min and vertex.

Chapter 5

Getting Started, pp. 260–262

1. a) (v) c) (ii) e) (iv)
   b) (vi) d) (i) f) (iii)
2. a) $\sin A = \frac{12}{13}, \cos A = \frac{5}{13}, \tan A = \frac{12}{5}$
   b) $\sin A = \frac{8}{17}, \cos A = \frac{15}{17}, \tan A = \frac{8}{15}$
3. a) $\angle A \doteq 27°$ b) $b \doteq 3$ c) $\angle A \doteq 50°$ d) $d \doteq 16$
4. a) 12 cm b) 10 m
5. a) $\sin A = \frac{4}{13}, \cos A = \frac{12}{13}, \tan A = \frac{1}{3}; \angle A \doteq 18°$
   b) $\sin D = \frac{5}{7}, \cos D = \frac{5}{7}, \tan D = 1; \angle D \doteq 44°$
   c) $\sin C = \frac{12}{13}, \cos C = \frac{4}{13}, \tan C = 3; \angle C \doteq 72°$

6. a) 0.7660 b) 0.9816 c) 3.0777
7. a) 47° b) 11° c) 80°
8. a) $\theta = 71°, \phi = 109°$ b) $\theta \doteq 72°, \phi \doteq 18°$
9. a) 27° b) 2.3 m
10. a) Answers may vary. E.g., Given the triangle below, calculate the length of h to the nearest metre.



$$\tan 31° = \frac{h}{18}$$ ← I knew one angle and the side adjacent to that angle. I needed to determine the length of the opposite side, so I used tangent.

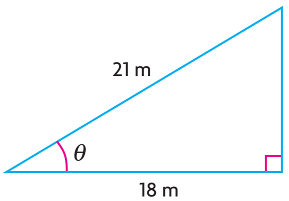
$$18 \times \tan 31° = \overset{1}{\cancel{18}} \times \frac{h}{\underset{1}{\cancel{18}}}$$ ← To solve for h, I multiplied both sides of the equation by 18.

$$18 \times \tan 31° = h$$

$$11 \text{ m} \doteq h$$ ← I rounded to the nearest metre.

The height of the triangle is about 11 m.

b) Answers may vary. E.g., Given the triangle below, calculate the measure of angle θ to the nearest degree.



$$\cos \theta = \frac{18}{21}$$ ← I knew the hypotenuse and the side adjacent to angle θ, so I used cosine.

$$\theta = \cos^{-1}\left(\frac{18}{21}\right)$$ ← To solve for θ, I used the inverse cosine key on my calculator.

$$\theta \doteq 31°$$ ← I rounded to the nearest degree.

Angle θ is about 31°.

Lesson 5.1, pp. 271–273

1. a) 0.2588 b) 0.5736
2. a) 22° b) 45°
3. a) $\sin A = \frac{3}{5}$, $\cos A = \frac{4}{5}$, $\tan A = \frac{3}{4}$; $\angle A \doteq 37°$

   b) $\sin D = \frac{6.9}{13}$, $\cos D = \frac{11}{13}$, $\tan D = \frac{6.9}{11}$; $\angle D \doteq 32°$
4. a) 8 cm b) 11 cm
5. a) $x \doteq 62°, y \doteq 28°, z = 17$ c) $x \doteq 64°, y \doteq 26°, q \doteq 4$

   b) $i = 8, j \doteq 7$ d) $x = 18°, l \doteq 3, j \doteq 10$
6. a) (Eiffel Tower) 254 m c) (Leaning Tower of Pisa) 56 m

   b) (Empire State Building) 381 m d) (Big Ben's clock tower) 97 m

   Order of heights (tallest to shortest): (b), (a), (d), (c)
7. 7.4 m
8. 26°
9. a) 0.3 b) 18°
10. 120 m
11. a) 30.91 m b) 29.86 m
12. a) nothing b) scaffolding c) planks
13. Answers may vary. E.g., They could place the pole into the ground on the opposite bank of the river (side B). Then they measure the angle of elevation from the other bank (side A). The width of the river can be calculated using tangent.

$$\tan \theta = \frac{h}{x}$$

$$x = \frac{h}{\tan \theta}$$, where h is the height of the pole and θ is the angle of elevation

14. 105 m
15. a) 63° b) 4.22 m c) 2.6 m
16. No, the height of the array will be 3.3 m.
17. 29 m
18. a) 18.4 m

    b) (Jodi) 85.7 m, (Nalini) 135.0 m

    c) (pole) 5.5 m, (Jodi) 19.4 m, (Nalini) 30.6 m

Lesson 5.2, pp. 280–282

1. a) 8.3 cm^2 b) 43.1 cm^2
2. In $\triangle ATB$, calculate AB using tangent. In $\triangle CTB$, calculate BC using tangent. Then add AB and BC. The length is about 897.8 m.
3. Karen; Karen's eyes are lower than Anna's. Thus, the angle of elevation is greater.
4. a) tangent; Tangent relates a known side and the length we must find.

   b) 26 m
5. No. The height of a pyramid is measured from the very top of the pyramid to the centre of the base. I don't know how far that point on its base is from the person measuring the angle of elevation.
6. Darren can only store the 1.5 m plank in the garage.
7. a) 58.5 m b) 146 m c) 87.7 m
8. 12 m
9. 31 m
10. 22.2 m
11. a) 35° b) 0.8 m
12. a) 180 cm^2 b) (volume) 18 042 cm^3, (surface area) 5361 cm^2
13. a) 54° b) 24 703 m
14. Draw a perpendicular from the base to divide x into two parts, x_1 and x_2. Use cosine to solve for x_1 and x_2. Then, add x_1 and x_2 to determine x.

$$\cos 24° = \frac{x_1}{148} \quad \text{and} \quad \cos 19° = \frac{x_2}{181}$$

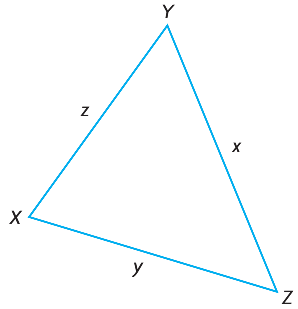
$$x = x_1 + x_2$$

$$x \doteq 306$$

15. 12 cm
16. 0.7 m^2

Lesson 5.3, pp. 288–290

1. **a)**



b) $\frac{\sin X}{x} = \frac{\sin Y}{y} = \frac{\sin Z}{z}$ or $\frac{x}{\sin X} = \frac{y}{\sin Y} = \frac{z}{\sin Z}$

2. **a)** $x \doteq 4.6$ **b)** $\theta \doteq 24°$

3. **a)** $b \doteq 12$ cm **b)** $\angle D \doteq 49°$

4. $q \doteq 9$ cm

5. **a)** 75° **b)** 82 m

6. **a)** $\angle C \doteq 39°$, $b \doteq 4.7$ cm **c)** $\angle C \doteq 53°$, $b \doteq 11.6$ cm
b) $\angle C \doteq 74°$, $b \doteq 8.7$ cm **d)** $\angle C \doteq 71°$, $b \doteq 10.8$ cm

7. **a)** 20.3 cm **b)** 13.6 cm^2

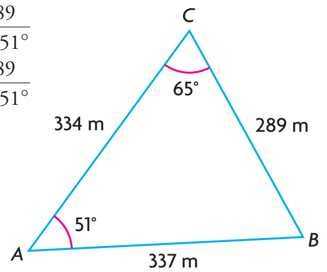
8. **a)** $\angle A = 75°$, $a \doteq 13$ cm, $b \doteq 13$ cm
b) $\angle M \doteq 58°$, $\angle N \doteq 94°$, $n \doteq 11$ cm
c) $\angle Q = 55°$, $q \doteq 8$ cm, $s \doteq 10$ cm
d) $\angle D \doteq 57°$, $\angle F \doteq 75°$, $f \doteq 10$ cm

9. **a)** $\angle A \doteq 42°$, $\angle B \doteq 68°$, $b \doteq 14.6$
b) $\angle D = 94°$, $d \doteq 21.2$, $e \doteq 13.1$
c) $\angle J \doteq 31°$, $\angle H \doteq 88°$, $h \doteq 6.1$
d) $\angle K \doteq 61°$, $\angle M \doteq 77°$, $m \doteq 14.0$
e) $\angle P \doteq 36°$, $\angle Q \doteq 92°$, $q \doteq 2.0$
f) $\angle Z = 61°$, $x \doteq 5.2$, $y \doteq 7.6$

10. (1.9 m chain) 52°, (2.2 m chain) 42°

11. Calculate $\angle B$, then use the sine law to determine b and c.

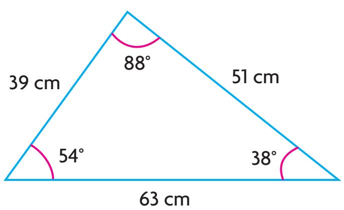
$$\frac{b}{\sin 64°} = \frac{289}{\sin 51°}$$
$$\frac{c}{\sin 65°} = \frac{289}{\sin 51°}$$



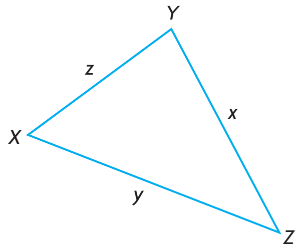
Phones A and B are farthest apart.

12. Answers may vary. E.g., The primary trigonometric ratios only apply when you have a right triangle. If you have a triangle that doesn't have a right angle, you would have to use the height of the triangle in order to use primary trigonometric ratios. This would mean you use two smaller triangles, instead of the original one. If you use the sine law, you can calculate either an angle or side directly without unnecessary calculations.

13.



14. Answers may vary. E.g., Given any acute angle θ, the value of $\sin \theta$ ranges from 0 to 1. If θ gets very small, $\sin \theta$ approaches zero. But if θ gets close to 90°, $\sin \theta$ approaches 1. Suppose in $\triangle XYZ$, $\angle X$ is 90°.



Suppose that $\angle X$ is the largest angle. Let's look at $\angle Y$. Since Y is a smaller angle than X in $\triangle XYZ$, we have $\sin Y < \sin X$. Thus, $\frac{1}{\sin X} < \frac{1}{\sin Y}$. Multiplying through by x yields $\frac{x}{\sin X} < \frac{x}{\sin Y}$. But by the sine law, $\frac{x}{\sin X} = \frac{y}{\sin Y}$. Thus, the previous inequality becomes $\frac{y}{\sin Y} < \frac{x}{\sin Y}$. Cancelling $\sin Y$, we obtain $y < x$. The same argument applies to side z.

15. 15.1 m

16. **a)** 4.0 m, 3.4 m **b)** 85%

Mid-Chapter Review, pp. 292–293

1. 100 m

2. **a)** 23° **b)** 1.9 m

3. **a)** $x \doteq 4.4$ cm, $y \doteq 8.6$ cm, $\angle X = 27°$
b) $\angle K \doteq 44°$, $\angle L \doteq 46°$, $j \doteq 99.8$ cm
c) $m \doteq 13.2$ m, $n \doteq 24.2$ m, $\angle M = 33°$
d) $i \doteq 20.9$ m, $\angle I \doteq 59°$, $\angle G \doteq 31°$

4. 84°

5. 5.1 m^2

6. 3.9 km

7. 44°

8. **a)** 56° **b)** 126 m

9. **a)** $\angle E = 71°$, $d \doteq 24$, $f \doteq 18$
b) $\angle P = 51°$, $p \doteq 6$, $q \doteq 6$
c) $\angle C = 58°$, $b \doteq 24$, $c \doteq 22$
d) $\angle X = 103°$, $y \doteq 13$, $z \doteq 6$

10. **a)** 123 m **b)** 6 m

11. **a)** 68° **b)** 69 cm

Lesson 5.4, pp. 299–301

1. **i)** (a); In order to apply the sine law, we would need to know $\angle A$ or $\angle C$.
ii) $b^2 = a^2 + c^2 - 2ac \cos B$

2. **a)** $b \doteq 6.4$ cm **b)** $b \doteq 14.5$ cm

3. **a)** $\angle B \doteq 83°$ **b)** $\angle D \doteq 55°$

4. **a)** 12.9 cm **b)** 10.1 cm **c)** 8.1 cm

5. **a)** $a \doteq 11.9$ cm, $\angle B \doteq 52°$, $\angle C \doteq 60°$
b) $d \doteq 7.7$ cm, $\angle E \doteq 48°$, $\angle F \doteq 80°$
c) $h \doteq 7.2$ cm, $\angle I \doteq 48°$, $\angle F \doteq 97°$
d) $\angle P \doteq 37°$, $\angle Q \doteq 40°$, $\angle R \doteq 103°$

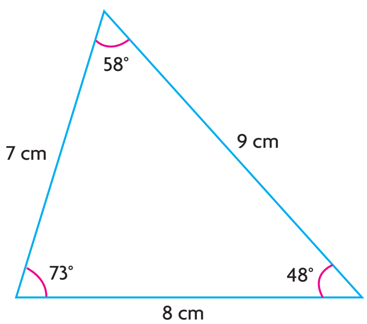
6. No, the interior angles are about 22°, 27°, and 130°.

7. 18 km

8. No; E.g., Calculate $\angle G$ using the fact that the sum of the interior angles equals 180°. Use the sine law to calculate f and h.
$\angle G \doteq 85°$, $f \doteq 45.3$ m, $h \doteq 59.7$ m
9. 7.1 km
10. Answers may vary. E.g., Use the cosine law to calculate r. Then use the sine law to calculate angle θ. $\theta \doteq 29°$
11. a) 13 cm b) 6 cm
12. a) Answers may vary. E.g., Two sailboats headed on two different courses left a harbour at the same time. One boat travelled 25 m and the other 35 m. The sailboats travelled on paths that formed an angle of 78° with the harbour. Calculate the separation distance of the sailboats.
$d^2 = 25^2 + 35^2 - 2(25)(35)\cos 78°$
$d \doteq 39$ m
13. a) (AX) 0.9 km, (AY) 2.0 km
b) (BX) 1.6 km, (BY) 0.6 km
c) 1.7 km

Lesson 5.5, pp. 309–311

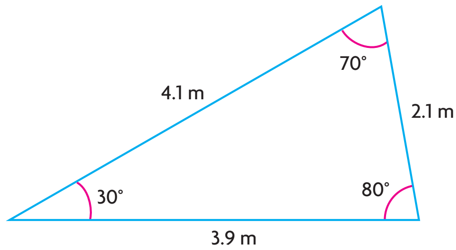
1. a) primary trigonometric ratios, $\sin 39° = \frac{x}{43.0}$
b) the sine law, $\frac{\sin \theta}{3.1} = \frac{\sin 42°}{2.2}$
c) the cosine law, $\cos \theta = \frac{3.6^2 + 5.2^2 - 4.1^2}{2(3.6)(5.2)}$
2. a) $x \doteq 27.1$ b) $\theta \doteq 71°$ c) $\theta \doteq 52°$
3. 486 cm^2
4. 1.4 m
5. 260.7 m
6. 50°
7. 27°
8. 0.004 s
9.



10. (perimeter) 32.7 cm, (area) 73.6 cm^2
11. 6.3 m
12. 107.7 m
13. (if $\angle ABC = 61°$) 78°, (if $\angle ABC = 65°$) 72°
14.

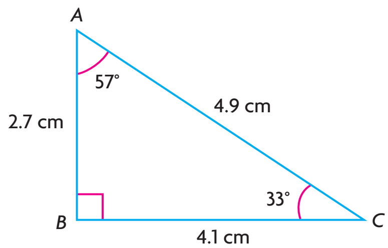
the cosine law	3rd problem	$x^2 = 1.7^2 + 3.8^2 - 2(1.7)(3.8)\cos 70°$ $x \doteq 3.6$ km
the sine law	1st problem	$\frac{b}{\sin 58°} = \frac{54}{\sin 51°}$ $b \doteq 59$ m $\frac{j}{\sin 71°} = \frac{54}{\sin 51°}$ $j \doteq 66$ m
primary trigonometric ratios	2nd problem	$\tan 41° = \frac{h}{11.4}$ $h \doteq 9.9$ m

15. 30.3 cm^2
16. 61 m
17.

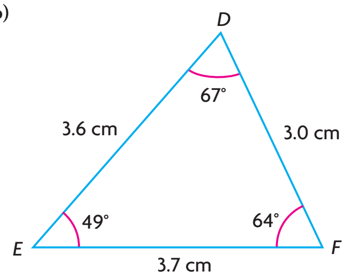


Chapter Review, pp. 314–315

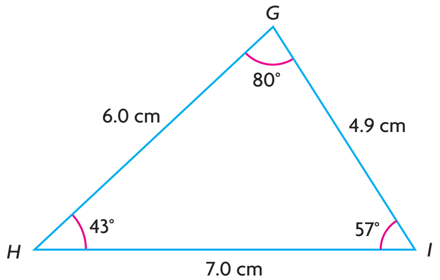
1. a) 4 cm b) 40°
2. 27°
3. a) 12 m b) 6.4 m^2
4. 84 m
5. a) $\angle A = 80°$, $a \doteq 19$ cm, $b \doteq 18$ cm
b) $\angle M \doteq 64°$, $\angle N \doteq 86°$, $n \doteq 20$ cm
c) $\angle Q = 45°$, $q \doteq 6$ cm, $s \doteq 9$ cm
d) $\angle D \doteq 40°$, $\angle F \doteq 88°$, $f \doteq 14$ cm
6. 59 m
7. a) $b \doteq 5$ cm, $\angle A \doteq 78°$, $\angle C \doteq 54°$
b) $\angle T = 90°$, $\angle U \doteq 53°$, $\angle V \doteq 37°$
c) $m \doteq 9$ cm, $\angle N \doteq 37°$, $\angle L \doteq 83°$
d) $y \doteq 6$ m, $\angle X = \angle C = 70°$
8. 47°
9. a)



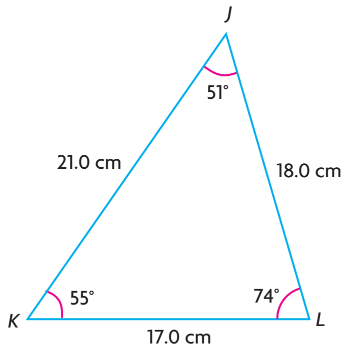
b)



c)



d)



10. **a)** 96°, 84°
b) 10.8 cm

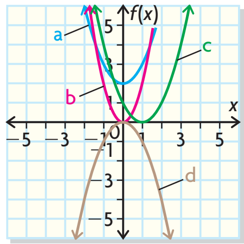
Chapter Self-Test, p. 316

1. 3 m
2. Yes, the angle of elevation is 6.4°, which is greater than 4.5°.
3. $x \doteq 111$ m, $y \doteq 108$ m
4. **a)** $\angle A \doteq 120°$, $\angle C \doteq 33°$, $a \doteq 29$ cm
b) $\angle F = 47°$, $d \doteq 31$ cm, $e \doteq 37$ cm
5. 2 m
6. 8 m
7. 795 m
8. 197 m

CHAPTER 6

Getting Started, pp. 320–322

1. **a)** (i) **c)** (vi) **e)** (iv)
b) (iii) **d)** (v) **f)** (ii)
2. **a)** about 175 m
b) about 30 s; Started fast for 8s; then slower; then top speed
c) for first 8 s started off slower; then sped up; at 20 s full speed
3. **a)** Moved to the right 5 units, stretched by a factor of 3, and moved up 4 units
b) Moved to the right 2 units, stretched by a factor of 2, and moved up 1 unit
c) Moved to the left 1 unit, compressed by a factor of 0.5, and moved down 3 units
d) Moved to the left 2 units, reflection in the x-axis and compressed by a factor of $\frac{1}{4}$, and moved down 4 units
4. **a)** **i)** 0.5; Truck is moving at a steady pace away from the detector.
ii) (0, 1.5); Spot where the truck starts away from the detector.
iii) 0; Truck is not moving for 2 s.
iv) (8, 0); Truck stops and this is how long it took for the truck to go the entire distance (to and from the detector).
b) domain: $\{t \in \mathbf{R} \mid 0 \le t \le 8\}$; range $\{t \in \mathbf{R} \mid 0 \le d \le 3\}$
5. **a)** $\sin A = \frac{3}{5}$; $\cos A = \frac{4}{5}$; $\tan A = \frac{3}{4}$
6.

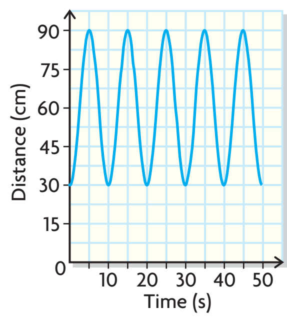


7. **a)** max: 4; zeros: (0, 0), (6, 0); domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \le 4\}$
b) min: −2.5; zeros: (−3, 0), (1, 0); domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid y \ge -2.5\}$
8.

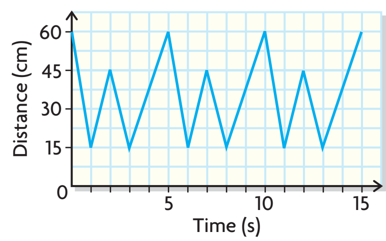
Definition:	Ways to Test:
A function is an equation that has only one corresponding value of y for each value of x.	Graph the equation on a co-ordinate grid. You should be able to draw a vertical line through the graph at any point and not have it intersect the graph at more than one point. If a vertical line does intersect the graph at more than one point, then the graph is not a function.
Function	
Example:	Non-examples:
$y = 6x^2 - 13$	$x = 6y^2 - 13$

Lesson 6.1, p. 325

1. **a)**

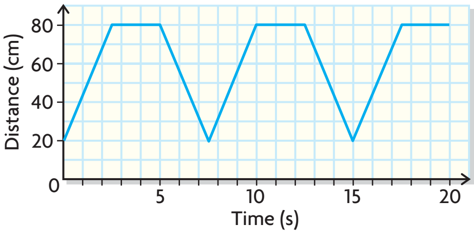


b)



Answers

2. Explanation: Start the paddle at 20 cm from the sensor. For 2.5 s, move to 80 cm. For 2.5 s, do not move the paddle. For 2.5 s more, move to 20 cm from the sensor. Repeat this 3 times.



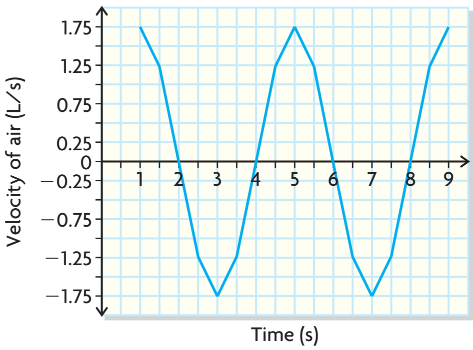
Lesson 6.2, pp. 330–334

1. **a)** yes; pattern is repeated
b) yes; pattern is repeated
c) no; not a function

2. days 89 and 119

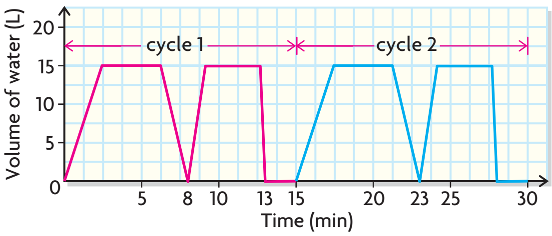
3. 5

4. **a)**

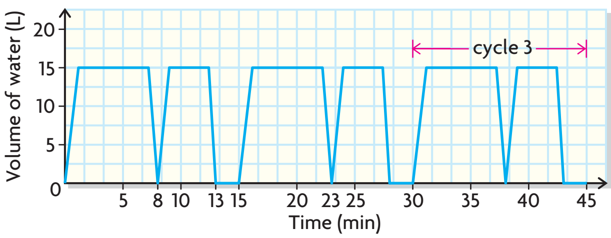


b) 4 s
c) breathing in, breathing out
e) 10 s, 12 s, 14 s, 16 s, 18 s

5. **a)**



b) 15 min; time for one dishwasher cycle
c)



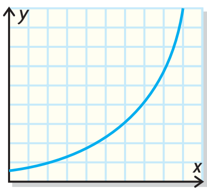
d) 240 L
e) domain: $\{t \in \mathbf{R} \mid 0 \le t \le 120\}$; range: $\{v \in \mathbf{R} \mid 0 \le v \le 15\}$

6. **a)** 8 s
b) time to complete one full rotation
c) 6 m; maximum height
d) 4 m
e) $t = 4$, $t = 12$, $t = 20$
f) $t = 2$, $t = 6$, $t = 10$, $t = 14$, $t = 18$, $t = 22$

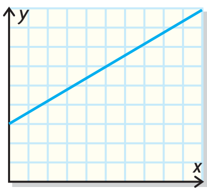
7. **a)** yes; repeating pattern
b) no
c) no
d) yes; repeating pattern
e) no
f) yes; repeating pattern

8. **a)** yes; heart beats regularly

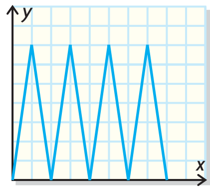
b) no



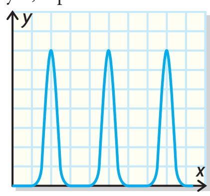
c) no



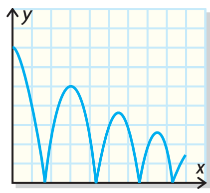
d) yes; steady pace



e) yes; repeated rotation



f) no

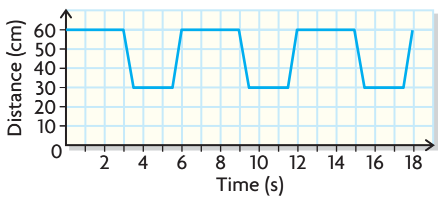


9. **a)** The wave pattern is repeating.
b) The change is 10 m.

10. **a)** The washer fills up with water, washes the dishes but does not add water, dishwasher empties of water, fills up again with a small amount of water, rinses again, and fills up one more time to rinse dishes, and empties again, and then waits 2 min before starting this cycle all over again.
b) 26 min
c) 50 L, 10 L, 50 L
d) 110 L

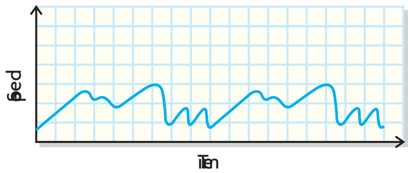
11. The paddle is moved in a steady back and forth motion in front of the detector.

12.

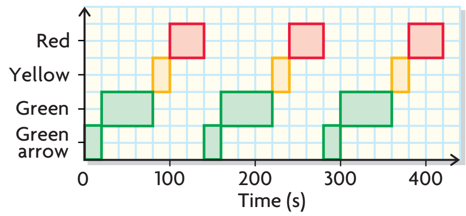


13. A periodic function is a function that produces a graph that has a regular repeating pattern over a constant interval. E.g. A search light on top of a lighthouse—this will go around in a circular period during the same time period and then keep repeating this pattern.

14. approximately periodic; speeds will vary slightly from lap to lap



15. **a)** The light is green for 60 s, yellow for 20 s, red for 40 s, and keeps repeating this pattern.
b) 120 s
c) 140 s



Lesson 6.3, pp. 339–343

1. **a)** yes; repeating pattern of waves
b) no; not the same shape as a sine function
c) no; not the same shape as a sine function

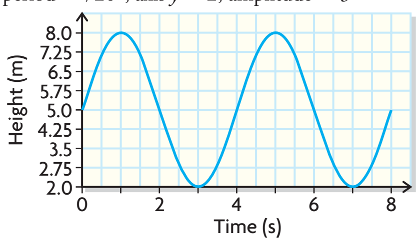
2. **a)** 2 s; takes time to get into rhythm
b) 2 s; time to complete one jump
c) $H = 2.25$
d) amplitude = 1.75 m; amplitude is maximum or minimum distance above axis

3. **a)** $D = 9$; where the swing is location between the up swinging and down swinging
b) $a = 5$
c) 4 s; time to complete one full swing
d) 4 m from the detector
e) No. When she is initially starting to swing, the amplitude between the successive waves would be getting larger.
f) yes, she's swinging away from the detector

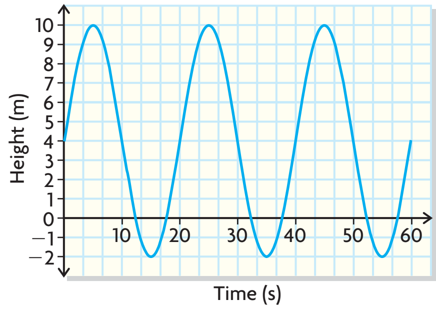
4. **a)** 0.03
b) $y = 0$
c) 4.5
d) period in seconds; axis: current in amperes; amplitude in amperes

5. **a)** period = 360°; axis $y = 3$; amplitude = 2
b) period = 360°; axis $y = 1$; amplitude = 3
c) period = 720°; axis $y = 2$; amplitude = 1
d) period = 180°; axis $y = -1$; amplitude = 1
e) period = 1440°; axis $y = 0$; amplitude = 2
f) period = 720°; axis $y = 2$; amplitude = 3

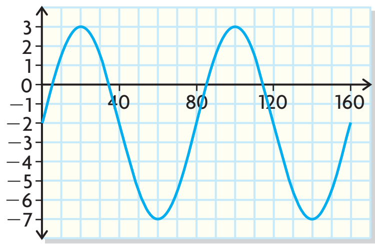
6. **a)**



b)

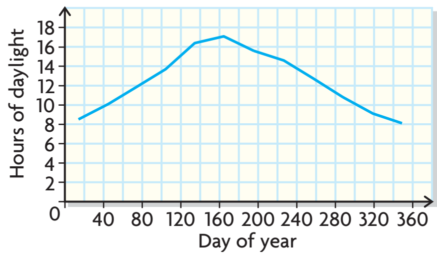


c)



7. **a)** periodic because it's a regular, predictable cycle
b) not sinusoidal; maximum values change from day to day, so do the minimum values

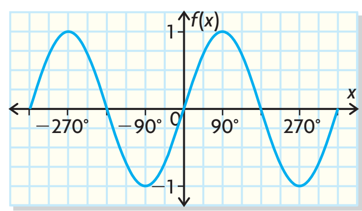
8. **a)**



b) 365 days
c) $y = 12.6$ h; average number of hours of sunlight per day over the entire year
d) $a = 4.5$ h; how many hours more or less one might expect to have from the average number of hours of sunlight per day

9. **a)** 20 m **c)** 2 m
b) 12 m **d)** 12 m

10. **a)**



b) period: 360°; axis: $y = 0$; amplitude: 1

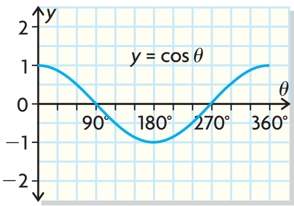
11. **a)**

Rotation (θ)°	0	30	60	90	120	150	180
cos θ	1	0.866	0.5	0	−0.5	−0.866	−1

Rotation (θ)°	210	240	270	300	330	360
cos θ	−0.866	−0.5	0	0.5	0.866	1

Answers

b)



c) yes; it's the sine curve shifted left 90°

d) period: 360°; axis: $y = 0$; amplitude $= 1$

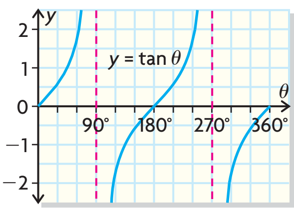
e) $\sin \theta° = \cos (\theta - 90°)$

12. a)

Rotation (θ)°	0	30	60	90	120	150	180
tan θ	0	0.58	1.73	E	−1.7	−0.58	0

Rotation (θ)°	210	240	270	300	330	360
tan θ	0.58	1.7	E	−1.7	−0.58	0

b)



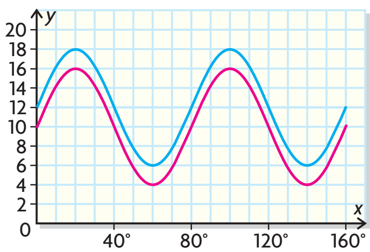
c) no; it's a periodic function

d) period: 180°; axis: $y = 0$; no amplitude because there are no maximum or minimum values; vertical asymptotes at 90° and 270°

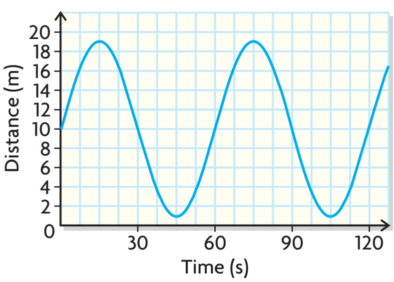
Lesson 6.4, pp. 348–353

1. Ferris wheel C: max. height 15 m; amplitude/radius = 7 m; speed = 0.55 m/s; period 80 s longer ride than A and B; speed between A and B; higher than A and B

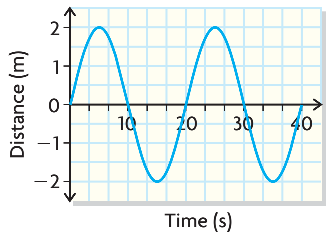
2.



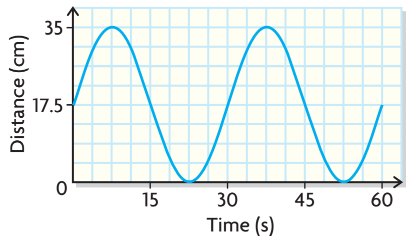
3. a)



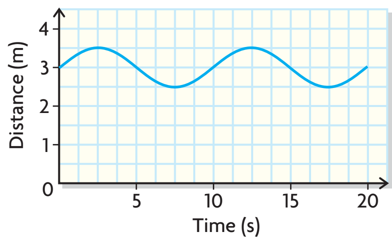
b)



c)



d)



4. a) $y = 0$; the brief instance in time when you are between inhaling and exhaling

b) 0.8 L/s

c) period: 6 s; amount of time to breathe in and out, one cycle

d) domain: $\{t \in \mathbf{R} \mid t \geq 0\}$; range: $\{V \in \mathbf{R} \mid -0.8 \leq V \leq 0.8\}$

5. a) deeper breaths; period is the same

b) amplitude

c) +0.16 L/s

6. A: $r = 2$; period = 6 s; speed = 6.3 m/s, height of axle = 1.5 m;
B: $r = 3$; period = 9 s; speed = 2.1 m/s, height of axle = 2.5 m

7. a) Experiment 1 and graph c); Experiment 2 and graph b); Experiment 3 and graph a); Experiment 4 and graph d)

b) graph a): $y = 20$; graph b): $y = 30$; graph c): $y = 30$; graph d: $y = 20$; for all graphs the equation of the axis represents the height of wheel axle above ground

c) graph a): 20 cm; graph b): 20 cm; graph c): 30 cm; graph d): 10 cm

d) graph a): 125.5 cm; graph b): 188.5 cm; graph c): 188.5 cm; graph d): 125.5 cm; circumference of the wheel

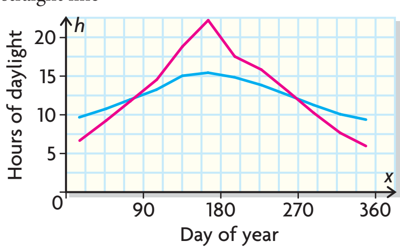
e) $r = 30$ cm

f) $r = 20$ cm

g) $h = 25$ cm

h) straight line

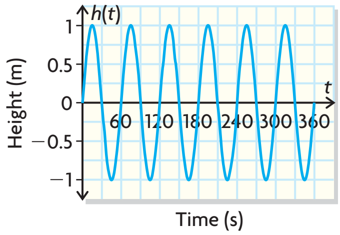
8. a)



b) 40° latitude (approximately): period: 365 days; axis: $h = 12$; amplitude: 3
60° latitude (approximately): period: 365 days; axis: $h = 12$: amplitude: 6.5
c) higher latitude results in larger deviations in the number of hours of sunlight throughout the year

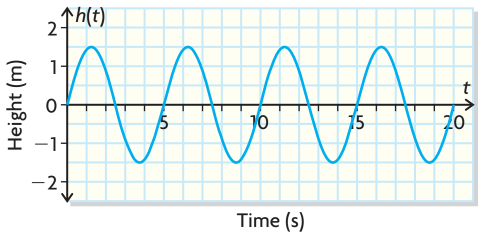
9. periods are the same; period = 0.5 s, equations of the axes are the same; $d = 0$, amplitudes differ; one is 2 cm, the other is 1.5 cm; implications: greater wind speed makes the pole vibrate farther from left to right

10. **a)**



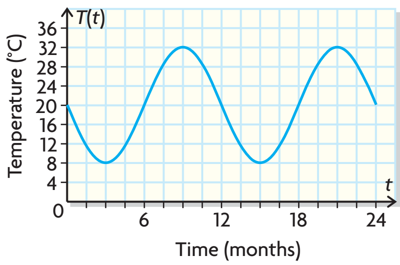
b) 60 s; based on period
c) radius = 1; based on amplitude
d) centre is at water level; based on the equation of the axis

11. **a)**



b) 5 s ; look at the time that passes between peaks
c) 12 waves; Since it takes 5 s for 1 cycle, 12 cycles would give you 60 s (1 min).
d) 3 m; distance between max and min values

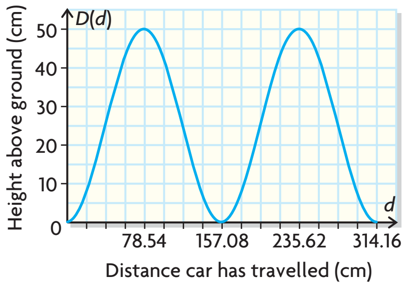
12. **a)**



b) 12 months or 1 year
c) between 8° C and 32° C
d) 20 °C

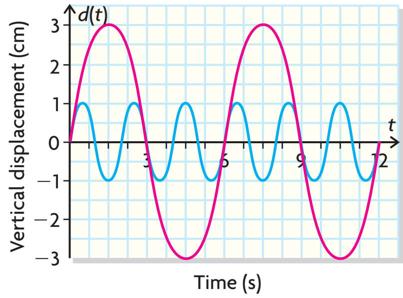
13. Look at the periods, amplitudes, domains, ranges, maximum, minimum, etc.

14. **a)**one cycle, or $\pi d = 50\pi$
b)



c) approximately 50 cm
d) between 170 and 180 cm

15. **a)** clockwise
b) 6 s
c) blue: smaller gear; red: larger gear

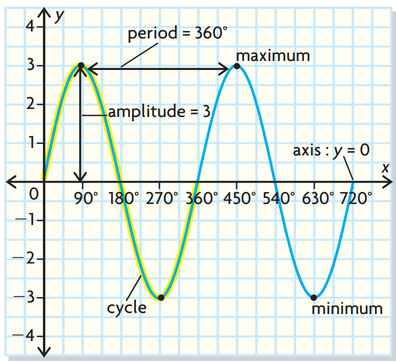


d) 3 cm
e) approximately 0.8 m
f) $d = 0$

Mid-Chapter Review, pp. 357–358

1. **a)** yes **b)** no **c)** yes **d)** no **e)** yes

2. Cycle–time it takes to complete one action or activity. E.g., dishwasher cycle, turn of Ferris wheel.
Period—change in maximum values—time it takes to go from one peak of the wave to the next peak of the wave.
Amplitude—vertical distance from its axis to its maximum (or minimum) value.
Equation of the axis—the value that is halfway between maximum and minimum value.
Maximum—highest value during the cycle.
Minimum—lowest value during the cycle.

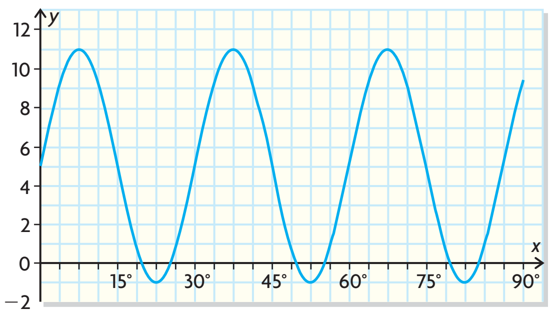


3. **a)** yes **b)** 60 psi **c)** 120 psi **d)** 80 s **e)** 20 s

4. **a)** 1.2 s **b)** 50 times **c)** $\{p \in \mathbf{R} | 80 \leq p \leq 120\}$

5. **a)** 2 s; the time it takes for the pendulum to swing one full cycle
b) $y = 0$, resting position of the pendulum
c) 0.25 m; how far the pendulum swings left or right from the resting position
d) 0.15 m

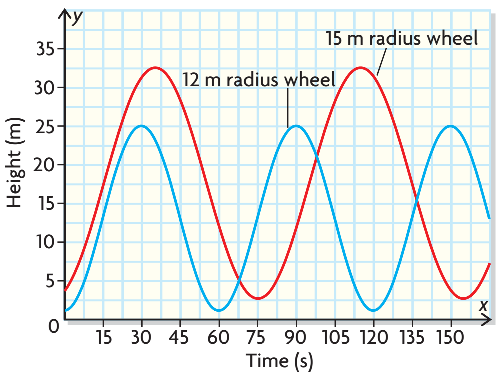
6.



7. **a)** period: 4; amplitude: 1; axis: $y = 3$
b) period: 180°; amplitude: 4; axis: $y = 8$

8. **a)** Monique: period: 3; amplitude: 2; axis: $d = 5$; Steve: period: 3.5, amplitude: 3; axis: $d = 5$
b) Monique is swinging faster.
c) Monique: $\{d \in \mathbf{R} | 3 \le d \le 7\}$;
Steve: $\{d \in \mathbf{R} | 2 \le d \le 8\}$

9. **a)**

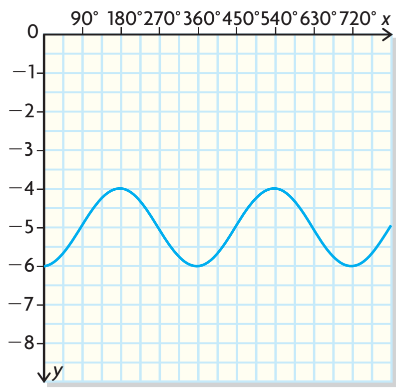


b) First Ferris wheel: perio: 60 s; amplitude: 12 m; axis: $y = 14$
Second Ferris wheel: period: 75 s; amplitude: 15 m; axis: $y = 18$
c) The 2 Ferris wheels are traveling at the same speed. This can be calculated by finding the circumference of both Ferris wheels and dividing each by the time each Ferris wheel takes to travel its circumference. This gives the distance travelled per second for each Ferris wheel, which is the same.

Lesson 6.5, pp. 365–367

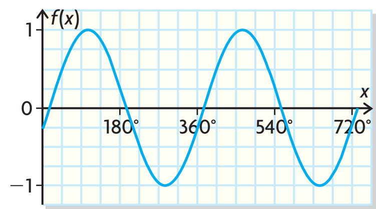
1. **a)** horizontal translation of −40; domain: $\{x \in \mathbf{R}\}$;
range: $\{y \in \mathbf{R} | -1 \le y \le 1\}$
b) vertical translation of 8; domain: $\{x \in \mathbf{R}\}$;
range: $\{y \in \mathbf{R} | 7 \le y \le 9\}$
c) horizontal translation of 60; domain: $\{x \in \mathbf{R}\}$;
range: $\{y \in \mathbf{R} | -1 \le y \le 1\}$
d) vertical translation of −5; domain: $\{x \in \mathbf{R}\}$;
range: $\{y \in \mathbf{R} | -6 \le y \le -4\}$

2.

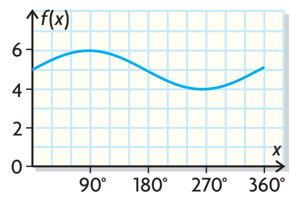


3. **a)** $f(x) = \sin(x + 70°) + 6$
b) amplitude: 1; period = 360°; axis: $y = 6$
c) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid 5 \le y \le 7\}$

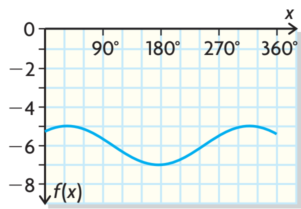
4. **a)** horizontal translation of 20



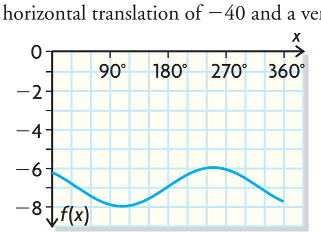
b) vertical translation of 5



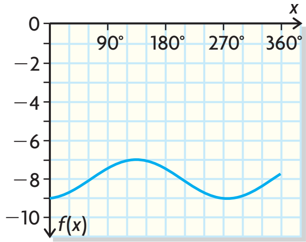
c) horizontal translation of 150 and a vertical translation of −6



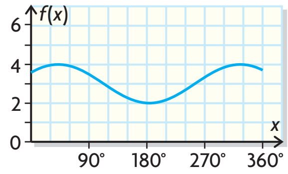
d) horizontal translation of −40 and a vertical translation of −7



e) horizontal translation of −30 and a vertical translation of −8



f) horizontal translation of −120 and a vertical translation of 3



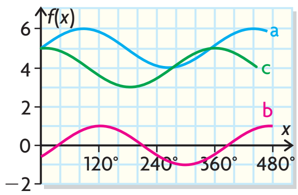
5. period, amplitude, and domain

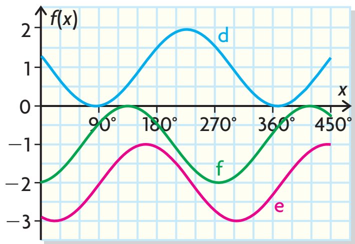
6. **a)** $f(x) = \sin(x - 15°) + 4$
b) $f(x) = \sin(x + 60°) - 7$
c) $f(x) = \sin(x - 45°) + 3$

7. $f(x) = \sin(x + 30°) - 5$

8. **a)** shifted vertically 4 units; shifted horizontally 90°
b) shifted vertically −3 units

9.





10. **a)** 360°
b) axis: $y = 1$; tire axle; vertical translation
c) 1; position of pebble above the ground
d) negative horizontal shift

11. **a)** same vertical transformation; same amplitude
b) The first is shifted horizontally −45°, and the other is horizontally shifted 90°.
c) The tires are the same size. The initial positions of the pebbles are different.

12. Answers may vary. E.g., $f(x) = \sin x + 4$; $f(x) = \sin(x - 90°) + 4$; $f(x) = \sin(x + 145°) + 4$

13.

Function	Horizontal Shift	Vertical Shift
$f(x) = \sin(x + 80)° - 7$	−80° or 80° to the left	−7 units or 7 units down
$f(x) = \sin(x - 10)° + 3$	10° or 10° to the right	3 units or 3 units up
$f(x) = \sin(x + 25)° + 3$	−25° or 25° to the left	9 units or 9 units up

14. If a number has been added or subtracted to the *x*-value, then there is a horizontal shift. If there is a number added or subtracted to the end of the funtion, then there is a vertical shift.

15. **a)** $f(x) = \sin(x + 45°) + 3$
b) $f(x) = \sin(x - 45°) - 2$

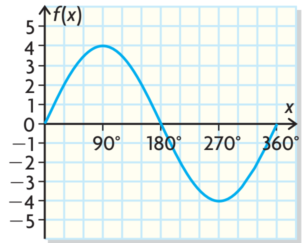
16. All three. $\sin(x - 90°) = \sin(x - 450°) = \sin(x - 810°)$

Lesson 6.6, pp. 373–376

1. **a)** amplitude 3 times larger
b) reflection in the *x*-axis; amplitude 2 times larger
c) amplitude 0.1
d) reflection in the *x*-axis; amplitude $\frac{1}{3}$

2. $f(x) = -5 \sin x$

3. **a)**



b) period: 360°; amplitude: 4; axis: $y = 0$
c) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -4 \le y \le 4\}$

4. **a)** vertical stretch
b) vertical compression
c) vertical compression
d) vertical stretch
e) vertical compression
f) vertical stretch

5. **a)** horizontal translation of −20°; vertical stretch of 3
b) reflection in the *x*-axis; vertical translation down 3
c) horizontal translation of 50°; vertical stretch of 5; vertical translation of −7
d) vertical stretch of 2; reflection in the *x*-axis; vertical translation of 6
e) horizontal translation of −10°; vertical stretch of 7; reflection in the *x*-axis
f) horizontal translation of 30°; vertical compression of 0.5; reflection in the *x*-axis; vertical translation of 1

6. $f(x) = 3 \sin(x + 20)$:
a) amplitude = 3; period = 360°; axis: $y = 0$
b) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -3 \le y \le 3\}$

$f(x) = -\sin x - 3$:
a) amplitude = 1; period = 360°; axis: $y = -3$
b) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -4 \le y \le -2\}$

$f(x) = 5 \sin(x - 50) - 7$:
a) amplitude = 5; period = 360°; axis: $y = -7$
b) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -12 \le y \le -2\}$

$f(x) = -2 \sin x + 6$:
a) amplitude = 2; period = 360°; $y = 6$
b) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid 4 \le y \le 8\}$

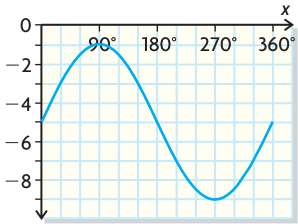
$f(x) = -7 \sin(x + 10)$:
a) amplitude = 7; period = 360°; $y = 0$
b) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -7 \le y \le 7\}$

$f(x) = -0.5 \sin(x - 30) + 1$:
a) amplitude = 0.5; period = 360°; axis: $y = 1$
b) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid 0.5 \le y \le 1.5\}$

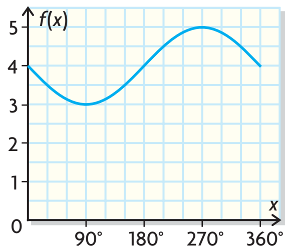
7. **a)** vertical stretch of 3; vertical translation of +5
b) vertical stretch of 2; reflection in the *x*-axis; vertical translation of −1

8. a) reflection in the x-axis
b) vertical stretch
c) horizontal translation
d) vertical translation

9. a) $f(x) = \sin(x - 135°) + 5$
b) $f(x) = \sin(x + 210°) - 7$

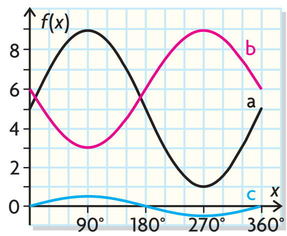
10. a)


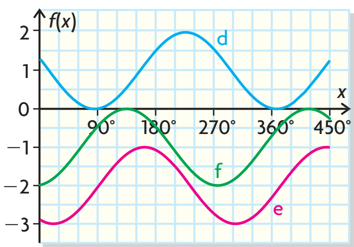
b) $f(x) = 4 \sin x - 5$

11. a)


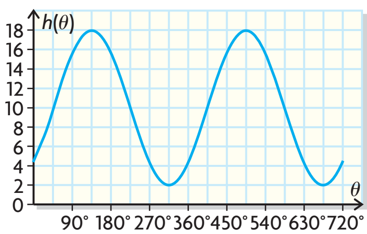
b) $f(x) = -\sin x + 4$

12. a) max: 3; min: −3
b) max: 2; min: −2
c) max: 10; min: 2
d) max: −2.5; min: −3.5

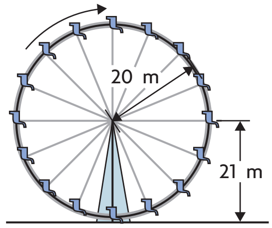
13.




14. period

15. a) height of axle
b) vertical translation
c)


d) $\{y \in \mathbf{R} \mid 2 \leq y \leq 18\}$
e) 8; represents radius of Ferris wheel
f) 13.4 m

16.


17. a) h: $f(x) = 4 \sin x + 6$
k: $f(x) = -\sin x + 5$
f: $f(x) = \sin x$
g: $f(x) = -0.5 \sin x - 1$
b) horizontal stretch of $\frac{1}{2}$

18. You can shift the graph vertically and then horizontally and/or compress/stretch.

19. a) 720° b) 1440° c) 180° d) 36°

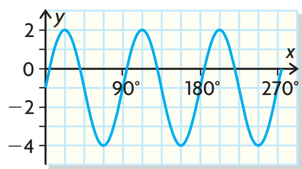
20. a) $y = 8$; height of axle
b) 6 m; length of windmill blade
c) 18 s; rotation speed of windmill
d) horizontal stretch
e) $y = 6 \sin(20(x - 4.5°)) + 8$
f) The period would be longer.
g) The graph would shift up 1 m.

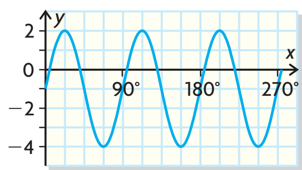
Chapter Review, pp. 378–379

1. a) yes
b) yes, once it reaches its constant speed
c) yes, assuming an ideal wave
d) yes

2. a) periodic
b) $\frac{1}{2}$ s
c) 3 cm
d) 1.5 s
e) The flat line would be longer.

3. a) −0.5 cm; makes sense because the function represents height relative to the ground, but it's digging and therefore below the ground
b) $y = 30$; height of axle on the rotating drum relative to the ground
c) 1 s; time for the drum to complete one full rotation
d) 35 cm; distance from the axle to the tip of the digging teeth

4.


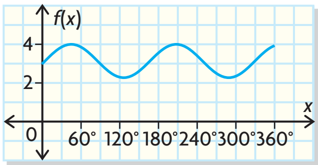
5.


6. a) $\{d \in \mathbf{R} \mid -1.5 \leq d \leq 1.5\}$; $\{d \in \mathbf{R} \mid -0.5 \leq d \leq 0.5\}$
b) 0.02 s; 0.025 s; one is idling/vibrating faster than the other
c) $y = 0$ for both; resting position
d) 1.5 mm, 0.5 mm; how much they shake to the left and right of their resting positions

7. a) amplitude: 1; period: 360°; axis: $y = 3$; max: 4; min: 2

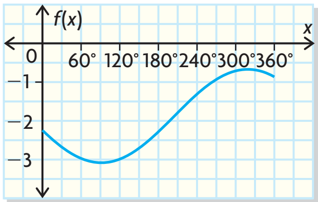
b) amplitude: 1; period: 360°; axis: $y = -2$; max: -1; min: -3

8. a)



domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid 2 \leq y \leq 4\}$

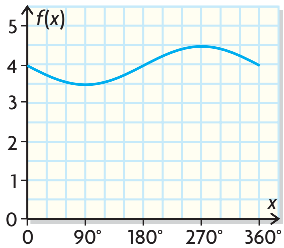
b)



domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -3 \leq y \leq -1\}$

9. a) $f(x) = -0.5 \sin x + 4$

b)



10. a) amplitude $= 3$; period $= 360°$; axis: $y = 0$; max: 3; min: -3

b) amplitude $= 2$; period $= 360°$; axis: $y = 0$; max: 2; min: -2

c) amplitude $= 4$; period $= 360°$; axis: $y = 6$; max: 10; min: 2

d) amplitude $= 0.25$; period $= 360°$; axis: $y = 0$; max: 0.25; min: -0.25

e) amplitude $= 3$; period $= 360°$; axis: $y = 0$; max: 3; min: -3

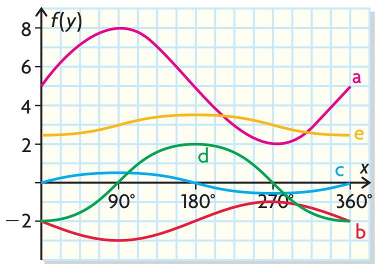
11. a) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid 2 \leq y \leq 8\}$

b) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -3 \leq y \leq -1\}$

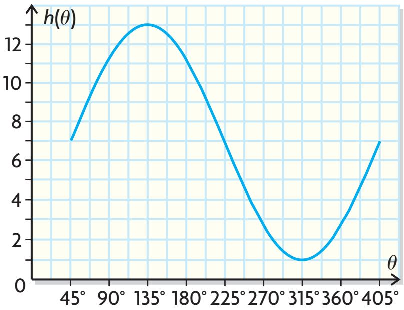
c) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -1.5 \leq y \leq -0.5\}$

d) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -2 \leq y \leq 2\}$

e) domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid 2.5 \leq y \leq 3.5\}$



12. a)



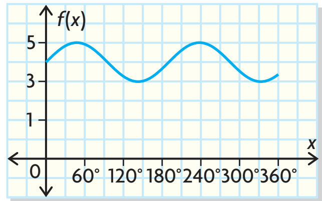
b) $\{h \in \mathbf{R} \mid 1 \leq h \leq 13\}$

c) 6; radius of Ferris wheel

d) 6.5 m

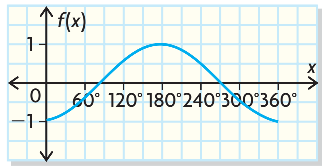
Chapter Self-Test, p. 380

1. a)



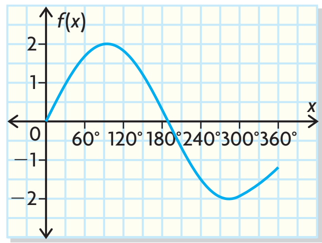
amplitude: 1; period: 360°; equation of the axis: $y = 4$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid 3 \leq y \leq 5\}$

b)



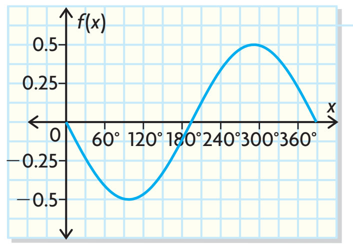
amplitude: 1; period: 360°; equation of the axis: $y = 0$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -1 \leq y \leq 1\}$

c)



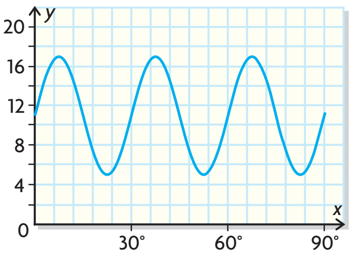
amplitude: 2; period: 360°; equation of the axis: $y = 0$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -2 \leq y \leq 2\}$

d)

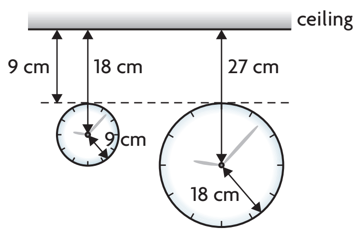


amplitude: 0.5; period: 360°; equation of the axis: $y = 0$; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} \mid -0.5 \leq y \leq 0.5\}$

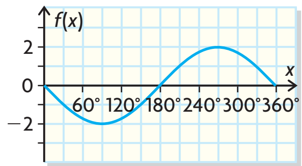
2.



3. **a)** period: 60 min for both; the amount of time it takes for the minute hand on each clock to make one complete revolution;
axis: $y = 27$; $y = 18$; how far the centre of the clock face is away from the ceiling;
amplitude: 18 cm; 9 cm; length of the minute hands
b) pointing up at the 12
c) $\{d \in \mathbf{R} | 9 \leq d \leq 45\}$; $\{d \in \mathbf{R} | 9 \leq d \leq 27\}$
d) 22 cm for the smaller clock; 36 cm for the larger clock
e)

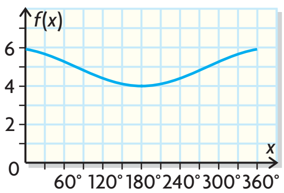


4. **a)** $f(x) = -2 \sin x$
b)



c) amplitude: 2; axis: $y = 0$; period: 360°; domain: $\{x \in \mathbf{R}\}$; range: $\{y \in \mathbf{R} | -2 \leq y \leq 2\}$

5.



6. **a)** $f(x) = 4 \sin x$
b) $f(x) = -\sin x + 2$
c) $f(x) = -2 \sin x - 1$
d) $f(x) = 3 \sin x + 4$

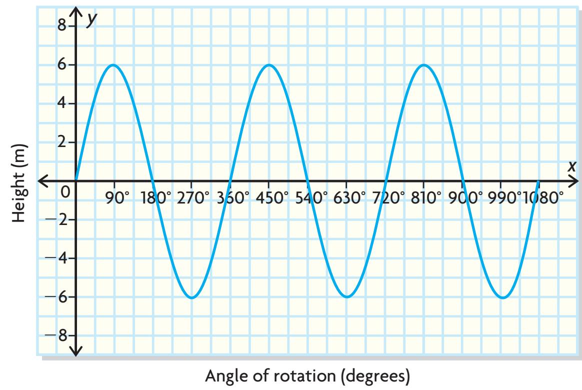
Cumulative Review Chapters 4-6, pp. 382–385

1. (b)	**6.** (d)	**11.** (a)	**16.** (d)	**21.** (b)	**26.** (c)
2. (d)	**7.** (a)	**12.** (a)	**17.** (b)	**22.** (c)	**27.** (b)
3. (b)	**8.** (c)	**13.** (b)	**18.** (a)	**23.** (d)	**28.** (b)
4. (d)	**9.** (c)	**14.** (d)	**19.** (a)	**24.** (b)	**29.** (c)
5. (d)	**10.** (d)	**15.** (c)	**20.** (b)	**25.** (a)	

30. **a)** $f(x) = -0.0732x^2 + 45.75$
b) 6.24 m

31. **a)** 224.93 m **b)** 428.98 m **c)** 27.67°

32. **a)**



b) amplitude: 6 m; period: 1 revolution; axis $y = 0$; range: $\{y \in \mathbf{R} | -6 \leq y \leq 6\}$
c) The graph would be shifted to the right 0.25 revolutions. Also, from 0 revolutions to 0.25 revolutions, the height relative to the platform would go from −6 m to 0 m, and the shifted graph would end at 3 revolutions, not 3.25 revolutions.

Chapter 7

Getting Started, p. 388–390

1. **a)** (viii) **b)** (vi) **c)** (iii) **d)** (v) **e)** (i) **f)** (iv) **g)** (ii) **h)** (vii)

2. **a)** 5.9 **b)** 7.8 **c)** 4.8 **d)** 6.7

3. **a)** $5 \times 5 \times 5 \times 5 = 625$
b) $(-4) \times (-4) \times (-4) = -64$
c) $-2 \times 2 = -4$
d) $(5 \times 2)(5 \times 2)(5 \times 2) = 1000$
e) $\frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$

4. **a)** 512 **b)** 14 641 **c)** 15 625 **d)** 361 **e)** 1024 **f)** 1024

5. **a)** 25 **b)** −25 **c)** −8 **d)** −8 **e)** 10 000 **f)** −10 000

6. **a)** −19 683 **b)** −19 683 **c)** 6561 **d)** 6561 **e)** 729 **f)** −729

7. **a)** −7 **b)** 110 **c)** 2500 **d)** 400 **e)** −200 **f)** −1

8. **a)** 9 **b)** 2 **c)** 3

9. **a)** $x = 4$ **b)** $m = 1$ **c)** $y = 3$ **d)** $x = 3$ **e)** $n = 3$ **f)** $c = 3$

10. **a)** $-\frac{5}{28}$ **b)** $\frac{35}{36}$ **c)** $\frac{5}{6}$ **d)** $1\frac{11}{12}$ **e)** $\frac{2}{3}$ **f)** $1\frac{4}{5}$

11. **a)** linear **b)** quadratic **c)** quadratic

Lesson 7.1, p. 394

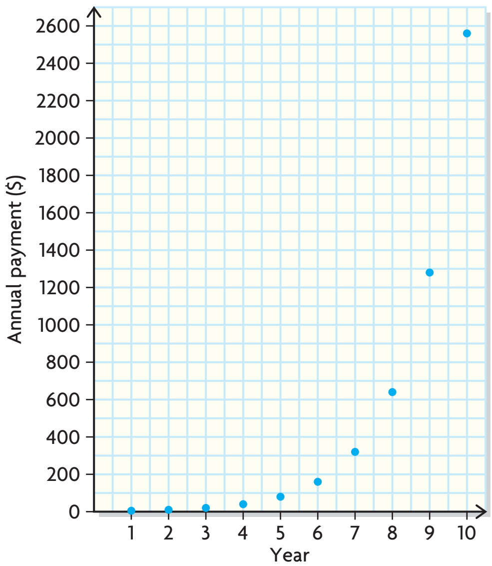
1. The curve would eventually be the same as the room temperature.

2. **a)** It would take longer to cool down.
b) It would cool down much faster.

3. a)

Year	Annual Payment ($1000)
1	5
2	10
3	20
4	40
5	80
6	160
7	320
8	640
9	1280
10	2560

b)



c) They are both exponential. The cooling curve is decay and the payment curve is growth.

Lesson 7.2, p. 399–401

1. **a)** 4^8 **b)** 13^{14} **c)** 7^3 **d)** 12^9

2. **a)** 7 **b)** 6^5 **c)** 9^2 **d)** 5^3

3. **a)** 2^{12} **b)** 12^9 **c)** 10^{28} **d)** 3^{24}

4. **a)** Answers may vary. E.g., $3^2 \times 3^3 = 3 \times 3 \times 3 \times 3 \times 3 = 3^5$
$3^2 \times 3^3 = 3^{2+3} = 3^5$

b) Answers may vary. E.g., $\frac{2^3}{2} = \frac{2 \times 2 \times 2}{2} = 2 \times 2 = 2^2$
$2^3 \div 2 = 2^{3-1} = 2^2$

c) Answers may vary. E.g., $(4^2)^3 = 4^2 \times 4^2 \times 4^2 = 4^{2+2+2} = 4^6$
$(4^2)^3 = 4^{2\times3} = 4^6$

5. **a)** 3^3 **b)** 10^4 **c)** 7^5 **d)** 6^5 **e)** 9 **f)** 8^2

6. **a)** 2^{18} **b)** 5^3 **c)** 7^{18} **d)** 8^2 **e)** 10^4 **f)** 4

7. **a)** 10^3 **b)** 8^3 **c)** 13^{12} **d)** 5^3

8. **a)** $\left(\frac{4}{3}\right)^3 = \frac{64}{27}$ **c)** $\left(\frac{2}{5}\right)^4 = \frac{16}{625}$
b) $\left(\frac{1}{9}\right)^2 = \frac{1}{81}$ **d)** $\left(\frac{5}{4}\right)^2 = \frac{25}{16}$

9. **a)** x^8 **b)** m^2 **c)** y^{21} **d)** a^8 **e)** a^6 **f)** b^5

10. **a)** 2^6 **b)** 3^{10} **c)** 3^{15} **d)** $(-2)^{12}$ **e)** $\left(\frac{1}{2}\right)^6$ **f)** $\left(\frac{1}{5}\right)^6$

11. **a)** 4 **b)** 1 **c)** 10 000 **d)** 625

12. **a)** Clare multiplied the bases.
b) $3^2(2^2)^2 = 3^2(2^4) = 9(16) = 144$

13. **a)** Multiply all the terms in the numerator by adding the exponents on the terms with the same base. Then divide the numerator by the denominator by subtracting the exponents on the terms with the same base.
b) x^3y^2 **c)** -72

14. **a)** Since n will equal $a + b$ and n is even, $a + b$ must be even. Therefore, $a + b$ must be even.
b) m must be even

15. **a)** No, they do not have the same value.
$(-5)^2 = 25, \quad -5^2 = -25$
b) $(-5)^2 = 25, \quad (-5)^3 = -125$
Conjecture: If the sign of the base is negative and the exponent is odd, the value of the power will be negative. If the sign of the base is negative and the exponent is even, the value of the power will be positive.

16. **a)** $n = 3$ **b)** $m = 14$

17. **a)** $16x^6$ **b)** $125x^9y^{12}$ **c)** $\frac{2}{3x^6y^2}$

18. **a)** Answers may vary. E.g., $x = \frac{1}{2}$
b) $x = \frac{1}{\sqrt{2}}$
c) Answers may vary. E.g., $x = 1$
d) not possible

Lesson 7.3, p. 407–409

1. **a)** $\frac{1}{4^6}$ **b)** $\left(\frac{3}{7}\right)^5 = \frac{3^5}{7^5}$ **c)** 8^2 **d)** $\frac{1}{(-3)^2}$

2. **a)** 1 **b)** $\frac{1}{125}$ **c)** $\frac{8}{27}$ **d)** $\frac{1}{16}$

3. **a)** 0.015 625 **b)** 0.015 625 **c)** 0.064 **d)** -8

4. **a)** $\frac{1}{100}$ **b)** $\frac{1}{16}$ **c)** 32 **d)** 343 **e)** $\frac{1}{81}$ **f)** 1

5. **a)** 9^4 **b)** 6^2 **c)** 8^{11} **d)** 17^2 **e)** $(-3)^1$ **f)** $(-4)^0$

6. **a)** 2^{12} **b)** $(-5)^{-11} = \frac{1}{(-5)^{11}}$ **c)** $(-12)^{-10} = \frac{1}{(-12)^{10}}$ **d)** 3^2 **e)** $9^{-5} = \frac{1}{9^5}$ **f)** 7^{24}

7. a) 11^9 c) 4^3 e) $(-8)^0 = 1$
b) $\frac{1}{9^{12}}$ d) 10^6 f) 5

8. a) $13^{-1} = \frac{1}{13^1}$ c) $10^4 = 10\,000$ e) $2^{-6} = \frac{1}{2^6} = \frac{1}{64}$
b) $3^4 = 81$ d) $6^0 = 1$ f) $5^3 = 125$

9. a) 0 c) $\frac{5}{64}$ e) $\frac{32}{3}$
b) $\frac{15}{16}$ d) 5 f) $\frac{1}{2}$

10. Negative exponents indicate that you need to move the decimal place to the left and this will give you very small numbers.

11. a) $x^0 = 1$ c) w^6 e) a^5
b) m^{18} d) a^{12} f) $b^{-15} = \frac{1}{b^{15}}$

12. a) $x = 0$ c) $n = -4$ e) $b = -5$
b) $m = 5$ d) $k = -1$ f) $a = 3$

13. a) Sasha's solution is incorrect because he multiplied the bases to get 4. He added the exponents correctly. Then, he correctly evaluated 4^{-1}, except that he made the whole number negative. Negative exponents do not change the sign of the number. Vanessa multiplied the exponents instead of adding them. After this error, the expression was evaluated correctly.
b) $2^{-2} \times 2 = 2^{-1} = \frac{1}{2^1} = \frac{1}{2}$

14. a) $2^{12} = 4^6 = 8^4 = 16^3 = 4096$
b) Write each base using powers of two:
$16^3 = (2^4)^3 = 2^{12}$
$8^4 = (2^3)^4 = 2^{12}$
$4^6 = (2^2)^6 = 2^{12}$
c) Answers may vary. E.g., $3^6 = 9^3 = 27^2$

15. $\frac{y^{-4}(x^2)^{-3}y^{-3}}{x^{-5}(y^{-4})^2}$, $(y^{-5})(x^5)^{-2}(y^2)(x^{-3})^{-4}$, $\frac{x^{-3}(y^{-1})^{-2}}{(x^{-5})(y^4)}$

Lesson 7.4, p. 415–417

1. a) $\sqrt{49} = 7$ c) $\sqrt[4]{81} = 3$ e) $\sqrt[4]{16} = 2$
b) $\sqrt[3]{-125} = -5$ d) $\sqrt{100} = 10$ f) $-\sqrt{144} = -12$

2. a) $1024^{\frac{1}{2}} = 32$ c) $27^{\frac{4}{3}} = 81$ e) $16^{\frac{1}{4}} = 2$
b) $1024^{\frac{1}{5}} = 4$ d) $(-216)^{\frac{5}{3}} = 7776$ f) $25^{-\frac{1}{2}} = \frac{1}{5}$

3. a) 2.05 c) 1.75 e) 0.22
b) 0.5 d) 3.46 f) 0.12

4. a) -2 c) 2 e) $-\frac{1}{3}$
b) -2 d) -32 f) 3

5. length of the side of the cube, 0.3 cm

6. a) $7^{\frac{5}{2}}$ c) 16^4 e) $10^{-\frac{5}{4}}$
b) $3^{\frac{7}{2}}$ d) $12^{\frac{1}{2}}$ f) 2^5

7. a) $\frac{1}{3^2}$ c) 8^5 e) 3
b) $\frac{1}{5^4}$ d) $\frac{1}{4^{1.2}}$ f) $\frac{1}{16}$

8. $10^{1.5} \doteq 31.55$; $10^{-0.5} \doteq \frac{1}{3.16}$

9. a) 10 c) 7 e) 5
b) 6 d) $\frac{1}{2}$ f) 18

10. a) $16^{\frac{11}{2}}$ c) $12^{\frac{-1}{4}} = \frac{1}{12^{\frac{1}{4}}}$ e) 4^2
b) $8^{-2} = \frac{1}{8^2}$ d) $11^{\frac{-13}{8}} = \frac{1}{11^{\frac{13}{8}}}$ f) $16^{\frac{1}{4}}$

11. a) $4^{\frac{13}{8}} = \sqrt[8]{4^{13}}$ c) $10^{\frac{1}{4}} = \sqrt[4]{10}$ e) $\frac{1}{\sqrt[5]{5}}$
b) $9^{\frac{19}{30}} = \sqrt[30]{9^{19}}$ d) $8^{\frac{1}{15}} = \sqrt[15]{8}$ f) $\sqrt[4]{4^9}$

12. a) 4.932 c) 0.358 e) 0.028
b) 11.180 d) 0.158 f) 0.164

13. $(-8)^{\frac{1}{3}} = -2, -(4)^{\frac{1}{2}} = -\sqrt{4} = -2$
They give the same answer.

14. a) $m^{\frac{5}{3}}$ c) $c^{\frac{5}{2}}$ e) $\frac{1}{s^{3.25}}$
b) $x^{\frac{7}{3}}$ d) b^2 f) $m^0 = 1$

15. a) $\frac{1}{t^{\frac{6}{5}}}$ c) $\frac{1}{y^3}$ e) x^1
b) $x^{\frac{41}{24}}$ d) a^3 f) $\frac{1}{b^3}$

16. $64^{\frac{-5}{3}} = \frac{1}{64^{\frac{5}{3}}} = \frac{1}{(\sqrt[3]{64})} = \frac{1}{y^3} = \frac{1}{1024}$

17. a) $M = 1.05^3 = 1.02$ d) $x = \sqrt[3]{125} = 5$
b) $T = 2.5^4 = 39.06$ e) $x = 8$
c) $N = 3^5 = 243$ f) $y = 81$

18. a) $1000^{\frac{2}{3}} = 100$ b) $64^{\frac{16}{3}} = 12\,816$

19. $32^{\frac{4}{5}} = (32^{\frac{1}{5}})^4 = 2^4 = 16$ or $32^{\frac{4}{5}} = (32^4)^{\frac{1}{5}} = 1\,048\,576^{\frac{1}{5}} = 16$

20. a) $\frac{17}{15}$ b) $-\frac{2}{3}$ c) $\frac{1}{\sqrt[5]{4}}$

21. $\frac{1}{\sqrt{9261}}$

22. (a)

Mid-Chapter Review, p. 419

1. a) 5^5 c) 16^{10} e) $\left(\frac{1}{10}\right)^2$ or $\frac{1}{10^2}$
b) 8^2 d) $\frac{1}{(-4)^9}$ f) 7^{10}

2. a) $\frac{1}{x^2}$ c) $\frac{1}{b^5}$ e) n^{14}
b) $\frac{1}{m^8}$ d) y^2 f) $\frac{1}{y^4}$

3. a) $\frac{7}{50}$ c) 0 e) $-\frac{7}{64}$
b) $\frac{49}{64}$ d) 45 f) $\frac{1}{5}$

4. a) $\frac{3}{2}$ c) $\frac{9}{4}$ e) $\frac{2}{3}$
b) $-\frac{125}{8}$ d) 256 f) $\frac{1}{64}$

5. **a)** $a^{\frac{13}{15}}$ **b)** $b^{\frac{1}{2}}$ **c)** $\frac{1}{c^5}$ **d)** d^2 **e)** e^{11} **f)** $\frac{1}{f^{\frac{5}{12}}}$

6.

	Exponential Form	Radical Form	Evaluation of Expression
a)	$100^{\frac{1}{2}}$	$\sqrt{100}$	10
b)	$16^{0.25}$	$\sqrt[4]{16}$	2
c)	$121^{0.5}$ or $121^{\frac{1}{2}}$	$\sqrt{121}$	11
d)	$(-27)^{\frac{5}{3}}$	$\sqrt[3]{-27^5}$ or $(\sqrt[3]{-27})^5$	-243
e)	$49^{2.5}$	$\sqrt{49^5}$ or $(\sqrt{49})^5$	16 807
f)	$1024^{0.1}$ or $1024^{\frac{1}{10}}$	$\sqrt[10]{1024}$	2
g)	$\left(\frac{1}{2}\right)^{\frac{9}{3}}$ or $\left(\frac{1}{2}\right)^3$	$\sqrt[3]{\left(\frac{1}{2}\right)^9}$	$\frac{1}{8}$ or 0.125

7. **a)** 3.659 **b)** 46.062 **c)** 0.072 **d)** 1.414 **e)** -2.160 **f)** 25

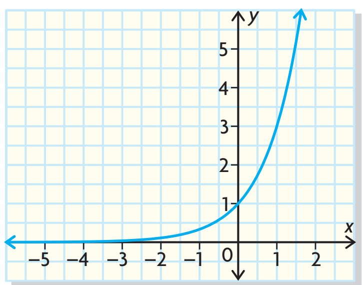
8. **a)** 1 953 125 **b)** 16 **c)** 3 **d)** 4

Lesson 7.5, p. 423–424

1. **a)** exponential **b)** linear **c)** quadratic

2. **a)** **i)** y-intercept is 1

ii)

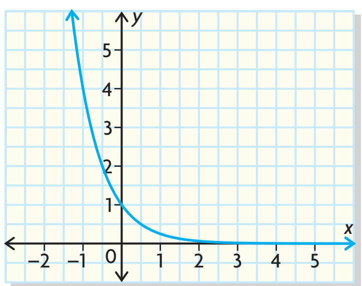


iii) domain: {x is any real number}
range: $\{y > 0\}$

iv) $y = 0$

b) **i)** y-intercept is 1

ii)

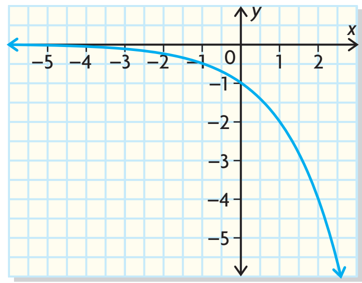


iii) domain: {x is any real number}
range: $\{y > 0\}$

iv) $y = 0$

c) **i)** y-intercept is -1

ii)

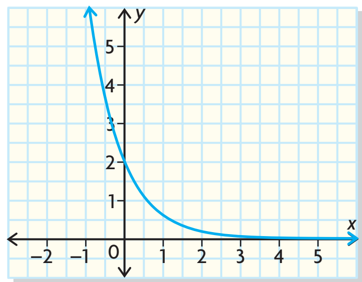


iii) domain: {x is any real number}
range: $\{y < 0\}$

iv) $y = 0$

d) **i)** y-intercept is 2

ii)

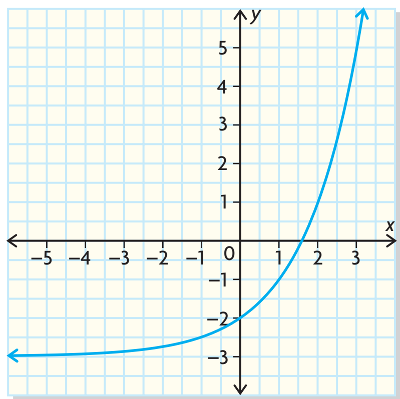


iii) domain: {x is any real number}
range: $\{y > 0\}$

iv) $y = 0$

e) **i)** y-intercept is -2

ii)



iii) domain: {x is any real number}
range: $\{y > -2\}$

iv) $y = -3$

f) **i)** y-intercept is 9

ii)

Answers

iii) domain: {x is any real number}
range: $\{y > 5\}$
iv) $y = 5$

3. a) $h(x)$ is exponential. It has a variable as an exponent.
b) The first differences are not constant but are related to each other by a factor of 4.
c) $f(x)$ is linear because it has a degree of 1. $g(x)$ is quadratic because it has a degree of 2.
d) The first differences for $f(x)$ are constant. The second differences for $g(x)$ are constant.

4. a) (ii) c) (i) e) (v)
b) (vi) d) (iii) f) (iv)

Lesson 7.6, p. 429–432

1. a) approximately \$6400
b) around \$12 500
c) Yes, it is approx. 18 years.

2. a) 0.25 is the initial coverage of the pond.
b) 1.1 is 1 + 10%. 10% is the rate of growth.
c) 65%

3. a) 364 552 c) 19 e) 551 222
b) 2.2% per year d) $P = P_0(1.022)^t$

4. a)

	Initial Value	Growth Rate	Number of Growth Periods
i)	18	5%	22
ii)	64 000	10%	12
iii)	750	100%	4

b) i) 52.65 ii) 200 859.42 iii) 12 000

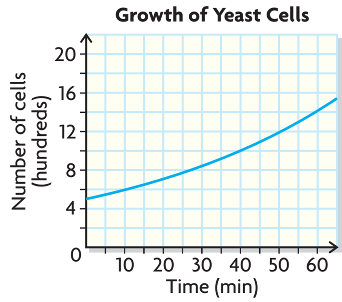
5. a) 20 cells c) 15 h e) The doubling times are the same for any amount chosen.
b) 80 cells d) 15 h

6. a) For: $N = 12(1 + 0.04)^t$, N represents the total number of guppies after t weeks. There are 12 guppies to start with and they grow at a rate of 4% per week.
b) 17 guppies
c) No. We assume the growth rate will slow as the aquarium becomes more crowded.

7. a) $V = 5000(1.0325)^n$; V represents value and n represents the number of years
b) $P = 2500(1.005)^t$; P represents population and t represents the number of years
c) $P = (2)^d$; P represents population and d represents the number of days

8. a) $V = 2000(1.06)^n$ b) \$2524.95
c) \$2676.45, \$151.50 subtract \$2524.95 from \$2676.45
d) \$6414.27 and \$6799.13; \$384.86
e) fourth year: \$151.50, twentieth year: \$384.86
Money grows faster the longer that it has been invested for.

9. a)

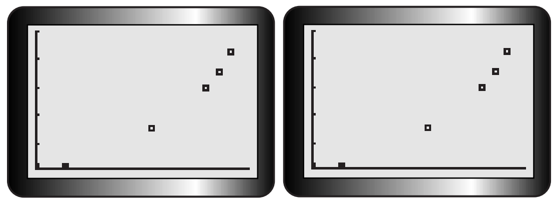


b) It takes about 63 min for the number of cells to triple.
c) Extend the horizontal axis to the left and extend the graph to the left.

10. a) 200%, initial population = 24 000 c) 648 thousand
b) $N = 24\,000(3)^n$ d) 99 ants

11. a) $y = 1.33^x$ b) 67 641 stores

12. a)



b) $P(n) = 6(1 + 0.08)^n = 6(1.08)^n$
c) It should be close to the data.
d) The equation comes close to this population.

13. a) 4.8 m
b) The height of the tree should get greater each year but slow down as the tree gets older.

14. approximately 3.9%

15. on the 29th day

Lesson 7.7, p. 437–440

1. a)

	Initial Value	Decay Rate	Number of Decay Periods
i)	100	25%	28
ii)	32 000	44%	12
iii)	500	2.5%	20

b) i) 0.03 ii) 30.44 iii) 301.34

2. a) approximately 58% b) approximately 50 years

3. a) \$15 102.24 lost b) \$14 613.22

4. a) 19.62 b) 94.15 c) 1

5. a) $V = V_0(1 - 0.032)^d$; V represents the volume of air in the ball after d days. V_0 represents the original volume of air. The ball loses 3.2% of its volume each day.
b) approximately 737.53 cm^3
c) The ball will eventually have no volume of air. As a result, the equation will not fit once there is no air in the ball.

6. a) approximately 18 g b) 5 min

7. a) $I = (0.96)^n$; I represents the intensity of the light as a percent of the original intensity with n gels in front of the spotlight. With each gel, 96% of the light gets through.
b) approximately 88.5%
c) 7 gels

8. a) \$25 000 b) -15% c) \$15 353.13 d) \$3750 e) \$1957.52 f) approximately 4.25 years

9. a) The base of the power is $\frac{1}{2}$, which is less than 1.
b) 22
c) It is the time required for the temperature to reduce by $\frac{1}{2}$.
d) 68 °C
e) 37 °C

10. a) 48.4% b) 4800 years

11. a) $V = 25000(0.75)^n$. The car *depreciates* (loses value) at a rate of 25% per year.
b) $R = R_0\left(\frac{1}{2}\right)^{\frac{t}{4.5\times 10^9}}$. The amount of U_{238} is halved each time period.
c) $I = I_0(0.88)^n$. The light intensity is reduced by 12% with each metre of depth.

12. a) The population *declined* each year by an average *percent*.
b) $P = 13\,700(0.95)^n$; 13 700 was the initial population, 0.95 represents a 5% decline each year, and there are n years.
c) just after 2019

13. a)

Bounce	Max. Height after Bounce (m)
Initial height	5
1	$5 \times 0.80 = 4$
2	$4 \times 0.80 = 3.2$
3	2.56
4	2.048

b) approximately 1.05 m

14. a) The shirt loses a percent of its colour with each wash.
$C = 100(0.995)^n$; C is the percent of colour left. The shirt has 100% of its colour to begin with. The shirt has 99.5% of its colour left after each wash. There are n washes.
Algebraically by using the equation above and guessing and checking until you get a value of 85%. Graphically, by graphing the function and determining when the line falls below the 85% level.
b) 32 washes

15. a) 20% lost b) $M = 50(0.80)^d$ c) approximately 30.3 kg

Chapter Review, p. 444–445

1. a) 3^{13} b) $(-5)^2$ c) $\frac{1}{11^4}$ d) $(-9)^{10}$ e) $4^0 = 1$ f) $\frac{1}{6^2}$

2. a) 12^2 b) $(-8)^0 = 1$ c) $\frac{1}{20^{16}}$ d) 10^4

3. a) a^2 b) b^7 c) $\frac{1}{c^6}$ d) d^{18} e) $\frac{1}{e}$ f) f^6

4.

	Exponential Form	Radical Form	Evaluation of Expression
a)	$36^{\frac{1}{2}}$	$\sqrt{36}$	6
b)	$16^{\frac{5}{4}}$	$\sqrt[4]{16^5}$	32
c)	$1024^{\frac{1}{5}}$	$\sqrt[5]{1024}$	4
d)	$16\,807^{0.2}$	$\sqrt[5]{16\,807}$	7
e)	$-216^{\frac{4}{3}}$	$\sqrt[3]{-216^4}$	-1296

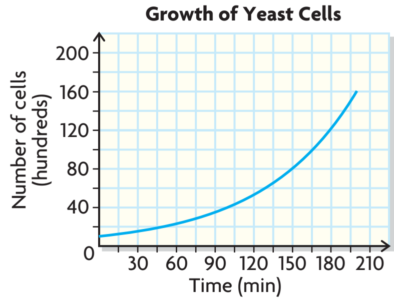
5. a) 4.92 b) -12.50 c) -2.10 d) 6.35 e) 0.03 f) 1.05

6. a) -5 b) 3 c) 3 d) 64 e) $\frac{1}{1024}$ f) -2

7. a) quadratic b) linear c) exponential d) exponential

8. a) approximately 178 000 b) 8 years c) approximately 22 years

9. a)



b) 8000 cells c) Extend the graph to the left to -180.

10. a) $V(t) = 2500(1.05)^t$
b) $P(t) = 750(1.02)^t$
c) $V(10) =$ \$4 072.24; value of coin in 2010; $P(10) = 914$; number of students enrolled in this school in 2013

11. a) 500 − card value in 2000
0.07 = 7% appreciation rate
b) \$1934.84
c) about 10 years and 3 months

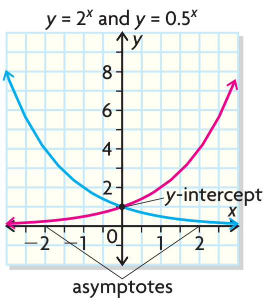
12. a) I is the intensity, in percent, at a depth of x metres. *100* is the percent of light at the surface. *0.94* is obtained by subtracting 6% from 1. 6% is the rate of decay of light intensity per metre.
b) approximately 37%

13.

Function	Exponential Growth or Decay	Initial Value (y-intercept)	Growth/ Decay Rate
$V = 125(0.78)^t$	decay	125	loss of 22%
$P = 0.12(1.05)^t$	growth	0.12	gain of 5%
$A = (2)^x$	growth	1	gain of 100%
$Q = 0.85\left(\frac{1}{3}\right)^x$	decay	0.85	loss of $\frac{2}{3}$

14. a) $A(n) = 500(1.05)^n$
b) \$578.81
c) \$78.81
d) No, in 6 years, he saves \$670.05.

Chapter Self-Test, p. 446

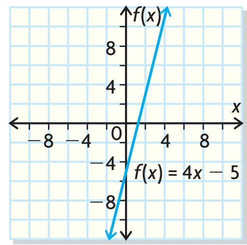
1. a) $\frac{1}{125}$ c) 2 e) -1
b) $\frac{16}{9}$ d) $\frac{1}{8}$ f) $\frac{1}{1000}$
2. a) $6^{\frac{1}{2}}$ c) 10^5 e) $\frac{1}{a^5}$
b) 4^5 d) 7^2 f) $\frac{1}{b^3}$
3. $4^{\frac{1}{2}} = 2$
4.


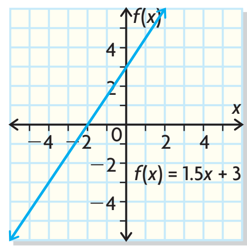
5. a) Car A starts at \$20 000 while car B has an initial value of \$25 000. Car B's value declines more quickly than car A's.
b) Since car B's value falls faster, it has a higher depreciation rate.
6. 23%
7. a) $P = 1600(1.015)^n$. The population, P, is initially 1600 and grows at 1.5% for n years.
b) $n = 2008 - 1980 = 28$, so $P \doteq 2428$

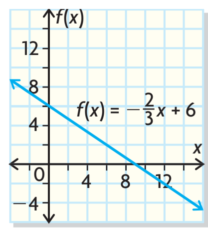
Chapter 8

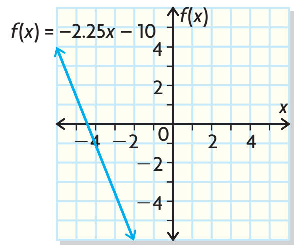
Getting Started, pp. 450–452

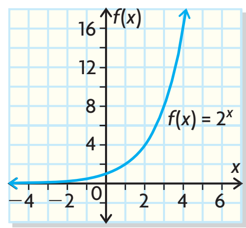
1. a) (ii) b) (i) c) (iv) d) (iii)
2. a) 0.35 b) 0.67 c) 0.085 d) 0.0275
3. a) 11.25 b) 51 c) 2.1 d) 145
4. a) 12 288, 0.000 73 c) 9, 4
b) 320, 0.078 125 d) 24 379.89, 29 718.95
5. a) $\frac{6}{73}$ c) $\frac{2}{3}$ e) $\frac{25}{13}$
b) $\frac{1}{2}$ d) $\frac{80}{73}$ f) $\frac{3}{2}$
6. a) 42 b) 117 c) 1825 d) 3
7. a) 0.35 c) 0.146 e) 0.0275
b) 0.05 d) 1.15 f) 0.1475
8. a) \$4.88 c) \$247.50 e) \$3.00
b) \$3.92 d) \$30.00 f) \$2000.00
9. a) 3.14 c) 1464.10 e) 1754.87
b) 0.49 d) 2220.06 f) $-281\ 825.99$

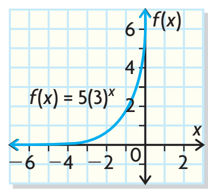
10. a)


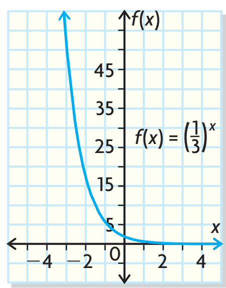
c)


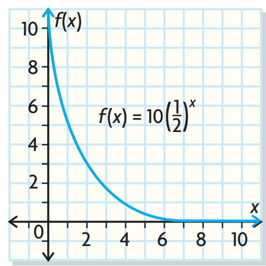
b)


d)


11. a)


c)


b)


d)


12. \$13.83
13. \$10 462.10

Lesson 8.1, pp. 459–461

1. a) \$3.00 b) \$4.50
2. a) Interest: \$97.88, Amount: \$772.88
b) Interest: \$1171.78, Amount: \$5432.78
3. a) Interest: \$94.58, Amount: \$694.58
b) Interest: \$112.03, Amount: \$862.03
4. a) Interest: \$120.00, Amount: \$620.00
b) Interest: \$480.00, Amount: \$2480.00
c) Interest: \$56.25, Amount: \$1306.25
d) Interest: \$23.08, Amount: \$1023.08
e) Interest: \$30.14, Amount: \$5030.14

5.

	Regular-Interest CSB, $11\frac{1}{4}$%, 5 years, $500			Compound-Interest CSB, $11\frac{1}{4}$%, 5 years, $500		
Year	Interest Earned ($)	Accumulated Interest ($)	Amount at End of Year ($)	Interest Earned ($)	Accumulated Interest ($)	Amount at End of Year ($)
1	56.25	56.25	556.25	56.25	56.25	556.25
2	56.25	112.50	612.50	62.58	118.83	618.83
3	56.25	168.75	668.75	69.62	188.45	688.45
4	56.25	225.00	725.00	77.45	265.90	765.90
5	56.25	281.25	781.25	86.16	352.06	852.06

6.

	Principal, *P* ($)	Interest Rate, *r* (%)	Time, *t*	Simple Interest, *I* ($)
a)	735.00	$5\frac{1}{2}$	27 days	2.99
b)	2548.55	8.25	240 days	138.25
c)	182.65	6.75	689 days	23.28
d)	260.00	38.08	2 months	16.50

7. 156 days
8. 19.7%
9. $3157.89
10. a) $1152.00 b) $1297.76
11. a) Compound interest earned is $740.17. Simple interest earned is $700. Therefore, the GIC that earns compound interest earns more.
 b) $40.17
12. Simple interest is calculated on the original principal. Compound interest is calculated on the principal plus interest earned so far.
13. a) $750.00 b) $795.80
14. $12 104.00
15. $5619.87

Lesson 8.2, pp. 468–470

1. a) $i = 0.09$, $n = 4$
 b) $i = 0.045$, $n = 12$
 c) $i = 0.0225$, $n = 8$
 d) $i = 0.0075$, $n = 36$

2.

	Principal ($)	Annual Interest Rate (%)	Time (years)	Compounding Frequency	Rate for the Compounding Period, *i* (%)	Number of Compounding Periods, *n*	Amount ($)	Interest Earned ($)
a)	400	5	15	annually	0.05	15	831.57	431.57
b)	750	13	5	semi-annually	0.065	10	1407.85	657.85
c)	350	2.45	8	monthly	0.002	96	424.00	74.00
d)	150	7.6	3	quarterly	0.019	12	188.01	38.01
e)	1000	4.75	4	daily	0.0001	1460	1157.19	157.19

3. a) $i = 0.0575$, $n = 3$
 b) $i = 0.02875$, $n = 10$
 c) $i = 0.014\ 375$, $n = 12$
 d) $i = 0.004\ 792$, $n = 24$

Answers

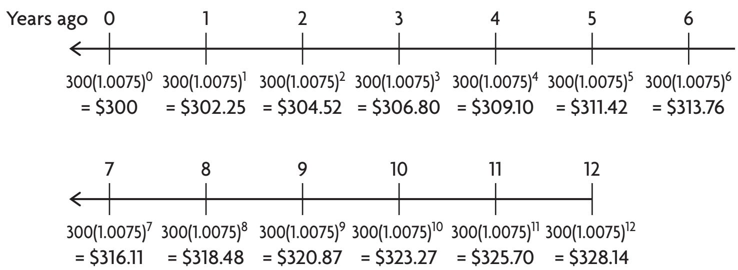
4.

	Principal ($)	Interest Rate (%)	Years	Compounding Frequency	i	n	Amount ($)	Interest Earned ($)
a)	800	8	10	annually	0.08	10	1727.14	927.14
b)	1500	9.6	3	semi-annually	0.048	6	1987.28	487.28
c)	700	$3\frac{1}{2}$	5	monthly	0.002 92	60	833.83	133.83
d)	300	7.25	2	quarterly	0.018 125	8	346.36	46.36
e)	2000	$4\frac{1}{4}$	$\frac{1}{2}$	daily	0.000 116 4	183	1157.19	157.19

5. $19 535.12

6. $1560.14

7.



Interest earned = $328.14 − $300 = $28.14

8. 0.126 24 or 12.625%

9. 0.06 or 6%

10. $n = 6.637$ or about 7 years

11. $13 040.38

12. **a)** Bank: $A = \$5255.80$; Dealer: $A = \$5265.95$

b) Take the dealer loan because the effective annual interest rate is lower.

13. $500 invested at 1%/a compounded annually for x years.

14. **a)**

Compounding Frequency	Number of Compounding Periods per Year	Formula	Amount ($)
annually	1	$1000(1 + 0.1)$	1100.00
semi-annually	2	$1000(1 + 0.05)^2$	1102.50
quarterly	4	$1000\left(1 + \frac{0.1}{4}\right)^4$	1103.81
monthly	12	$1000\left(1 + \frac{0.1}{12}\right)12$	1104.71
weekly	52	$1000\left(1 + \frac{0.1}{52}\right)^{52}$	1105.06
daily	365	$1000\left(1 + \frac{0.1}{365}\right)^{365}$	1105.16
hourly	8760	$1000\left(1 + \frac{0.1}{8760}\right)^{8760}$	1105.17

b) The largest increase in amount occurs when the compounding frequency is changed from annual to semi-annual. After the frequency change from annual to semi-annual, the amount increases minimally.

c) It appears that $1105.17 is a maximum amount. It would not be feasible to compound interest by the minute.

d) Banks have many accounts and investment vehicles. Computers are used to process the financial information. Hourly compounding frequencies would require too much computer time. The amount of increase in amount from daily to hourly would not be considered a significant benefit by bank customers.

15.

	Formula	P ($)	Compounding Frequency	i (%)	n	Annual Interest Rate (%)	Number of Years	A ($)	I ($)
a)	$145(1 + 0.0475)^{12}$	145	annually	0.047 5	12	4.75	12	253.06	108.06
b)	$850(1 + 0.195)^{5}$	850	annually	0.195	5	19.5	5	2 071.37	1221.37
c)	$4500\left(1 + \frac{0.0525}{365}\right)^{1095}$	4500	daily	0.000 144	1095	5.25	3	5 267.55	767.55
d)	$4500\left(1 + \frac{0.15}{12}\right)^{78}$	4500	monthly	0.012 5	78	15	6.5	11 858.37	7358.37
e)	$4500\left(1 + \frac{0.03}{4}\right)^{20}$	4500	quarterly	0.007 5	20	3	5	5 225.33	725.33

16. Answers may vary. E.g., larger terms offer the best rate of interest, but customers may prefer smaller terms if they want access to their money earlier.

17. 10.4%

18. $7472.58

19. n = 9.75 or about 10 years

Lesson 8.3, pp. 476–479

1. **a)** P = $86.38 **b)** P = $417.78

2.

	Future Value ($)	Annual Interest Rate (%)	Time Invested (years)	Compounding Frequency	i (%)	n	Present Value ($)	Interest Earned $I = A - P$ ($)
a)	4 000	5	15	annually	0.05	15	1924.07	2075.93
b)	3 500	2.45	8	monthly	$\frac{2.45}{1200}$	96	2877.62	622.38
c)	10 000	4.75	4	daily	$\frac{4.75}{36\,500}$	1460	8269.69	1730.31

3.

Years ago	0	1	2	3	4
	$\frac{150}{(1.05)^0}$ = $150	$\frac{150}{(1.05)^1}$ = $142.86	$\frac{150}{(1.05)^2}$ = $136.05	$\frac{150}{(1.05)^3}$ = $129.58	$\frac{150}{(1.05)^4}$ = $123.41

4.

	Future Value ($)	Annual Interest Rate (%)	Time Invested (years)	Compounding Frequency	i (%)	n	Present Value ($)	Interest Earned $I = A - P$ ($)
a)	8000	10	7	annually	0.1	7	4105.26	3894.74
b)	7500	13	5	semi-annually	0.065	10	3995.45	3504.55
c)	1500	7.6	3	quarterly	0.019	12	1196.74	303.26

5.

Years ago	0	0.5	1	1.5
	$\frac{5750}{(1.06)^0}$ = $5750	$\frac{5750}{(1.06)^1}$ = $5424.53	$\frac{5750}{(1.06)^2}$ = $5117.48	$\frac{5750}{(1.06)^3}$ = $4827.81

2	2.5	3
$\frac{5750}{(1.06)^4}$ = $4554.54	$\frac{5750}{(1.06)^5}$ = $4296.73	$\frac{5750}{(1.06)^6}$ = $4053.52

Answers

6. $8609.76
7. $4444.74
8. **a)** $1717.85, $8282.15 **b)** $1655.57, $8344.43
9. $74.35
10. $2862.81
11. $2768.38
12. **a)** $98 737.24 **b)** $151 262.76 **c)** $129 795.92
13. **a)** **i)** $21 500 **ii)** $13 081.40

    b) **i)** $100 000 **ii)** $28 008.45

14.

	Future-Value Formula	A ($)	Compounding Frequency	i (%)	n	Annual Interest Rate (%)	Number of Years	Present Value ($)
a)	$280\ 000 = P(1 + 0.0575)^{24}$	280 000	annually	0.057 5	24	5.75	24	73 186.17
b)	$16\ 000 = P(1 + 0.20)^{5}$	16 000	annually	0.20	5	20	5	6 430.04
c)	$10\ 000 = P\left(1 + \frac{0.0425}{365}\right)^{1460}$	10 000	daily	0.000 12	1460	4.25	4	8 436.73
d)	$9500 = P\left(1 + \frac{0.15}{12}\right)^{50}$	9500	monthly	0.012 5	50	15	4 years 2 months	5 104.72
e)	$1500 = P\left(1 + \frac{0.03}{4}\right)^{24}$	1500	quarterly	0.007 5	24	3	6	1 253.75

15. Savings account: $4347.68 must be invested now; GIC: $4369.20 must be invested now. Marshall should invest in the savings account since the present value required is less.
16. $2000
17. $911.39
18. $75 305.12

Lesson 8.4, pp. 486–488

1. Solutions are **in bold**.

	N	I%	PV	PMT	FV	P/Y	C/Y
a)	8	4.5	−600	0	**858.27**	1	4
b)	**11.6**	2.5	−6 000	0	8000	1	2
c)	5	**14.1**	−20 000	0	40 000	1	4
d)	1	0.6	**−847.62**	0	900	1	52

2. $54 059.13
3. Plan A
4. **a)** $16 288.95 **b)** $26 532.98 **c)** $43 219.42
5. **a)** present value: $4444.98, interest: $555.02
   b) present value: $10 625.83, interest: $2874.17
   c) present value: $8991.83, interest: $2208.17
   d) present value: $77 030.40, interest: $51 469.60
   e) present value: $797.31, interest: $52.69
   f) present value: $4849.55, interest: $1375.45
6. 5.95%
7. 11.032 years
8. 4.25%
9. 2 years
10. $4758.14
11. $5200.00
12. $4514.38
13. $3427.08
14.

	Month	0	1	2	3
a)	A ($)	465	471.98	479.05	486.24
b)	I ($)	0	6.98	14.05	21.24

15. Answers will depend on online calculators chosen. Similarities should include basic variables such as present value, future value, payments, i, n; differences in format, and so on.
16. Between 321.7% and 357.3%
17. Dealer: $P = 32\ 000$, $i = 0.002$, $n = 60$, $R = \$566.51$; Bank: $P = 29\ 000$, $i = 0.0045$, $n = 60$, $R = \$552.60$; The monthly payments for the loan to the bank are less than those to the dealer.
18. $16 637.84

Mid-Chapter Review, pp. 491–492

1.

	Principal ($)	Annual Interest Rate (%)	Time	Simple Interest Paid ($)	Amount ($)
a)	250	2	3 years	**15.00**	**265.00**
b)	**399.98**	2.5	200 weeks	38.46	**438.44**
c)	1000	3.1	18 months	46.50	**1046.50**
d)	5000	5	30 weeks	**144.23**	**5144.23**
e)	**750**	4.2	5 years	157.50	**907.50**
f)	**1500**	3	54 months	202.50	**1702.50**

2. 3 years

3.

Year	Your Investment (10% Simple Interest)		Friend's Investment (10% Compound Interest)	
	Interest Earned ($)	Accumulated Interest ($)	Interest Earned ($)	Accumulated Interest ($)
1	50.00	50.00	50.00	50.00
2	50.00	100.00	55.00	105.00
3	50.00	150.00	60.50	165.50
4	50.00	200.00	66.55	232.05
5	50.00	250.00	73.21	305.26
6	50.00	300.00	80.52	385.78
7	50.00	350.00	88.58	474.36
8	50.00	400.00	97.43	571.79
9	50.00	450.00	107.18	678.97
10	50.00	500.00	117.90	796.87

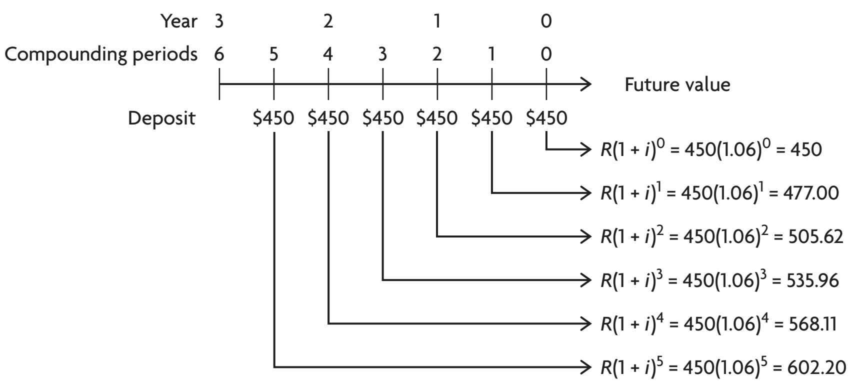
4.

	Principal ($)	Annual Interest Rate (%)	Years Invested	Compounding Frequency	Amount ($)	Interest Earned ($)
a)	400.00	5	15	annually	**831.57**	**431.57**
b)	350.00	2.45	8	monthly	**425.70**	**75.70**
c)	**420.05**	3.5	5	quarterly	500.00	**79.95**
d)	120.00	**3.2**	7	semi-annually	150.00	**30.00**
e)	2500.00	7.6	**1 yr 9 mths**	monthly	**2 850.00**	350.00
f)	10 000.00	7.5	3	quarterly	**12 497.16**	**2497.16**

5. $270.58
6. $1225.35
7. Option 1: A = $60 110.84; Option 2: A = $60 047.92; Option 1 is the better choice because it earns $62.92 more interest.
8. $7413.72
9. $752.31
10. $3233.46
11. 2.2 %
12. 14 years
13. 33 years
14. Bank A: $563.58, Bank B: $ 573.76; She should go with Bank B as it will provide Sarah with the most interest.

Lesson 8.5, pp. 498–500

1.

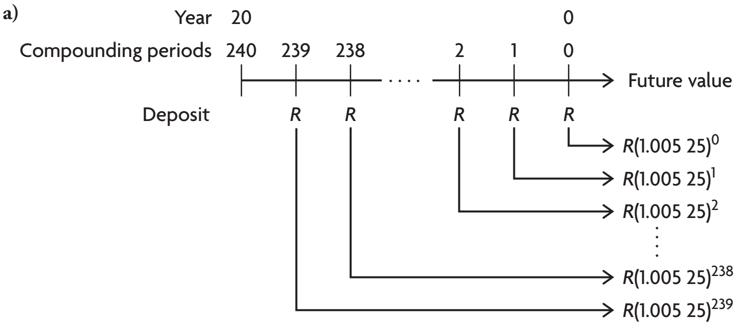


Answers

2. Geoff's investment earns $391.87 more than Marilyn's.
3. a) $4607.11 b) $29 236.22
4.

	Payment ($)	Interest Rate	Compounding Period	Term of Annuity	Amount ($)
a)	1000	8% per year	annually	3 years	**3 246.40**
b)	500	$7\frac{1}{2}$% per year	quarterly	8.5 years	**23 482.98**
c)	200	3.25% per year	monthly	5 years	**13 010.95**

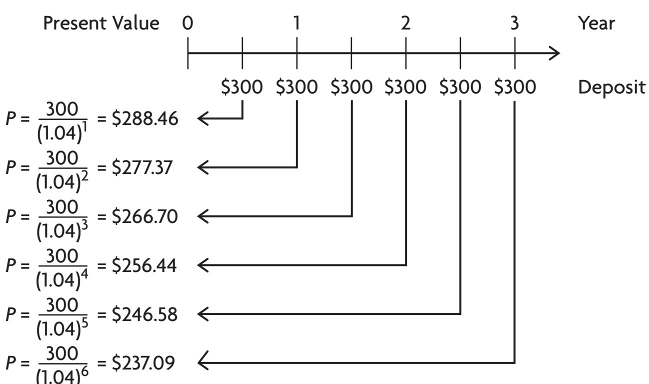
5. $348.92
6. $51 960.58; $1960.58
7. a) $451 222.88 b) $416 222.88
8. No; entertainment costs $2848.86, investment is worth $2743.74.
9. $7599.64
10. No. At the end of 8 months, he will have only $1601.57.
11. $3788.00
12. a)



b) $167.08 c) $268.12
13. Answers will vary; may include 8% compounded annually, annual payments of $400; 5% compounded monthly, monthly payments of $40.
14. a) $5466.13
b) $5330.00; Annuity (a) will earn the greater amount.
15. In the formula $A = \frac{R[(1 + i)^n - 1]}{i}$, n represents the number of compounding periods. If there were more payments than compounding periods, the formula would assume n payments and therefore miss out the extra payments. Similarly, if there were fewer payments, the formula would include payments that were not made.
16. $433.28
17. $556.05

Lesson 8.6, pp. 506–508

1.



$PV = \$1572.64$

2.

	Withdrawal ($)	Annual Interest Rate (%)	Compounding Period	Term of Annuity	*R* ($)	*i*	*n*	*PV* ($)
a)	750	8	annual	3 years	**750**	**0.08**	**3**	**1 932.82**
b)	450	7.5	quarterly	8.5 years	**450**	**0.018 75**	**34**	**11 238.20**
c)	225	3.25	monthly	5 years	**225**	$\frac{3.25}{1200}$	**60**	**12 444.69**

3. a) $2850.55 b) $3464.76
4. $721.37
5. $2081.32
6. $92.48
7. a) $2537.48 b) $128 747.84
8. $706.82
9. $783.49
10. $7770.40
11. a) $389.47
b) $23 368.36
c) Cash offer; payments to bank are $386.66, which is less than dealer's finance payments.
12. a) $961.63 b) $108.37
13. Answers may vary. E.g., If an annual rate of 5% is used, $R =$ $1060.66. For an annual rate of 7.5%, $R =$ $1187.02. For an annual rate of 10%, $R =$ $1321.51.
14. a) Answers may vary. E.g., Quarterly payments of $2500 for 9 years at 20%/a; annual payments of $2500 for 36 years at 5%/a
b) $41 367.13 for all annuities matching the given information
15. Answers may vary. E.g.,
a) Find quarterly payments at 8% for a 3-year annuity worth $2800 at maturity.
b) Find amount of a 5-year loan annuity at 6% interest with monthly payments of $350.
16. a) Answers may vary. E.g., suppose that there is an annuity that has an annual interest rate of 12% compounded quarterly with quarterly payments of $400 paid out over 6 years.

$$A = \frac{400\left[\left(1 + \frac{0.12}{4}\right)^{24} - 1\right]}{\frac{0.12}{4}}$$

$= \$13\,770.59$

Now suppose the duration of the annuity were doubled from 6 years to 12 years. The amount of the annuity would be

$$A = \frac{400\left[\left(1 + \frac{0.12}{4}\right)^{48} - 1\right]}{\frac{0.12}{4}}$$

$= \$41\,763.36$

Therefore, doubling the duration of an annuity does not double the amount of the annuity at maturity. Rather, it more than doubles the amount of the annuity.

b) Answers may vary. E.g., suppose that there is an annuity that has an annual interest rate of 12% compounded quarterly with quarterly payments of $400 paid out over 6 years.

$$A = \frac{400\left[\left(1 + \frac{0.12}{4}\right)^{24} - 1\right]}{\frac{0.12}{4}}$$

$= \$13\,770.59$

Now suppose the payment amount were doubled from $400 to $800. The amount of the annuity would be

$$A = \frac{800\left[\left(1 + \frac{0.12}{4}\right)^{48} - 1\right]}{\frac{0.12}{4}}$$

$= \$27\,541.18$

Therefore, doubling the payment amount does double the amount of the annuity at maturity.

17. a) $21 278.35 b) 8.17%
18. 5 years 3 months

Lesson 8.7, pp. 517–519

1. a) Interest = previous period's balance × interest rate per compounding period
b) Annual contribution + interest
2. a) $997.48
b) 19.41 periods or approximately 4 years 10 months; minimal impact on the duration of the loan
c) a): $19 949.60; b): $19 361.09
3. Variables to be determined are **in bold**.

	N	I%	PV	PMT	FV	P/Y	C/Y
a)	156	**0**	10 000	–350	0	12	12
b)	**0**	7.5	15 000	–500	0	12	12

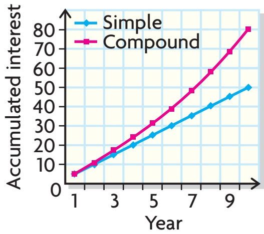
4. a) $216.25
b) $653.23
c) The payment in part (b) is about 3 times the payment in part (a) because payments are made $\frac{1}{3}$ as often. It is slightly more because payments earn interest on the interest, and with monthly payments there are more compounding periods for this to happen.
5. 4.96%
6. a) $597.58
b) $24 834.63; $19 282.07; $13 313.30; $6897.12; $0
c) $5854.85; $30 000
7. 10.33 years or 10 years 4 months
8. $18 649.01
9. $29 127.96
10. a) $307.75 b) $3464.88 c) $2286.34
11. Get low interest rate—reduces the amount of interest paid; Borrow as little as possible—just what you need—reduces the present value of the loan; Pay as much as possible each period—principal is paid down faster, interest amounts are reduced at a faster rate.
12. a) Answers will vary; for example, a car, a computer, a vacation
b) Answers will depend on information available.
c) Schedule should be calculated using similar formulas to those in Reflecting part F.
13. a) $459.35
b) about 31 more payments
c) $1603.20

Chapter Review, pp. 522–523

1.

	Principal ($)	Annual Interest Rate (%)	Years	Compounding Frequency	Amount ($)	Interest Earned ($)
a)	400.00	5	15	semi-annually	**839.03**	**439.03**
b)	450.00	4.5	10	monthly	**705.15**	**255.15**
c)	**622.87**	3.4	10	weekly	875.00	**252.13**
d)	508.75	3.7	3	semi-annually	568.24	**59.49**
e)	10 000.00	2.34	**4**	quarterly	**11 000.00**	1000.00

2. Answers may vary; for example:



The relationship between accumulated interest and year is linear for simple interest and exponential for compound interest, because simple interest is earned on the principal only, while compound interest earns interest on the interest as well.

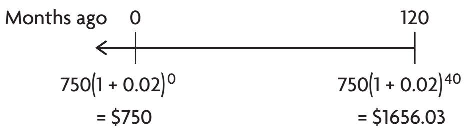
3. **a)** $6929.29 **b)** $9603.02

4. $7559.90

5. 8%/a

6. 17 years 6 months

7. **a)**



b) $45 301.49, $15 301.49

8. $11 000.73

9. **a)** 16 years old **b)** A little over 1 year less

10. **a)** 5-year term: $622.75; 8-year term: $439.51 **b)** $4827.96

11. $60 744.31

12. $9324.48

13.

	a)	b)	c)	d)
N	5	180	36	32
I	4.5	3.75	0	9
PV	0	0	10 000	0
PMT	−1500	0	−334.54	−2000
FV	0	200 000	0	0
P/Y	1	12	12	4
C/Y	1	12	12	4

14. $8530.20

15. $358.22

16.

Loan **$10 000**		**Start Year**	**0**
Annual Rate **0.08**		**End Year**	**5**
Rate per Period **0.0067**		**Number of Payments**	**60**
Compounding Periods per Year **12**		**Contribution**	**$202.76**
Payment Number	**Payment ($)**	**Interest**	**New Balance $**
0			10 000.00
1	202.76	66.67	9 863.91
2	202.76	66.09	9 727.24
3	202.76	65.17	9 589.65
4	202.76	64.25	9 451.14
5	202.76	63.32	9 311.70
6	202.76	62.39	9 171.33
7	202.76	61.45	9 030.02
8	202.76	60.50	8 887.76
9	202.76	59.55	8 744.55
10	202.76	58.59	8 600.38
11	202.76	57.62	8 455.24
12	202.76	56.65	8 309.13
13	202.76	55.67	8 162.13
14	202.76	54.69	8 014.06
15	202.76	53.69	7 864.99

17. $1548.95

Chapter Self-Test, p. 524

1. In simple interest, only the principal amount earns interest, whereas in compound interest, the interest earns interest as well.

2. $12 717.67, $2217.67

3. $13 367.01, $8132.99

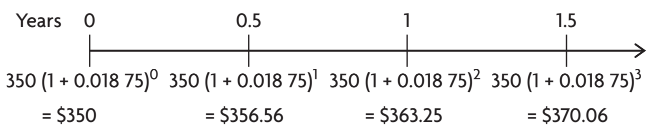
4. $16 783.48

5. $15 169.64

6. 1.96%

7. 390 weeks or 7 years 6 months

8.



9. $148.90

10. $60 880.81

11. An amortization table is used to show the amount of a regular payment, how much of the payment is interest, how much is used to reduce the principal, and the outstanding balance after each payment. A spreadsheet is useful in creating amortization tables and for analyzing the effects of changing the parameters of a loan problem.

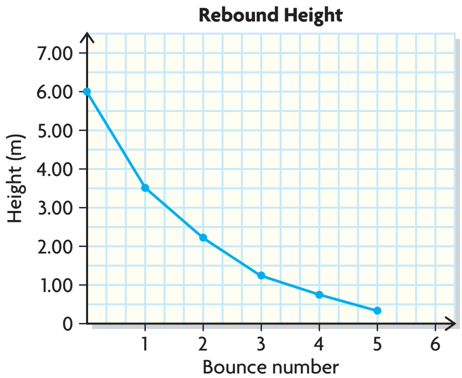
Cumulative Review Chapters 7–8, pp. 526–527

1. (a) **3.** (b) **5.** (c) **7.** (d) **9.** (a) **11.** (c)
2. (c) **4.** (c) **6.** (a) **8.** (c) **10.** (c) **12.** (b)

13. **a)**

Bounce	Height (m)
0	6.00
1	3.60
2	2.16
3	1.30
4	0.78
5	0.47

b)



c) $f(n) = 0.6 \times f(n - 1)$ or $f(n) = 6(0.60)^n$
d) $f(12) \doteq 0.013$
e) 6^{th} bounce

14. \$1028.24

15. Monthly payments: \$348.39; total interest: \$2722.72; value of car after four years: \$7912.13

Appendix A

A-1 Operations with Integers, p. 530

1. **a)** 3 **b)** 25 **c)** -24 **d)** -10 **e)** -6 **f)** 6

2. **a)** $<$ **b)** $>$ **c)** $>$ **d)** $=$

3. **a)** 55 **b)** 60 **c)** -7 **d)** 8 **e)** $\frac{15}{7}$ **f)** $\frac{1}{49}$

4. **a)** 5 **b)** 3 **c)** -9 **d)** 76 **e)** -12 **f)** -1

5. **a)** 3 **b)** -1 **c)** -2 **d)** 1

A-2 Operations with Rational Numbers, pp. 531–532

1. **a)** $-\frac{1}{2}$ **b)** $\frac{7}{6}$ **c)** $-\frac{19}{12}$ **d)** $-8\frac{7}{12}$ **e)** $-\frac{41}{20}$ **f)** 1

2. **a)** $-\frac{16}{25}$ **b)** $-\frac{9}{5}$ **c)** $\frac{2}{15}$ **d)** $\frac{3}{2}$ **e)** $-3\frac{2}{5}$ **f)** $32\frac{7}{24}$

3. **a)** 2 **b)** $-4\frac{3}{4}$ **c)** $\frac{16}{9}$ **d)** $-\frac{9}{2}$ **e)** $\frac{15}{2}$ **f)** $\frac{2}{3}$

4. **a)** $\frac{1}{5}$ **b)** $\frac{3}{10}$ **c)** $\frac{1}{15}$ **d)** $-\frac{1}{18}$ **e)** $\frac{36}{5}$ **f)** $-\frac{3}{8}$

A-3 Exponent Laws, p. 533

1. **a)** 16 **b)** 1 **c)** 9 **d)** -9 **e)** -125 **f)** 0.125

2. **a)** 2 **b)** 31 **c)** 9 **d)** $\frac{1}{18}$ **e)** -16 **f)** $\frac{13}{36}$

3. **a)** 9 **b)** 50 **c)** 4 194 304 **d)** $\frac{1}{27}$

4. **a)** x^8 **b)** m^9 **c)** y^7 **d)** a^{bc} **e)** x^6 **f)** $\frac{x^{12}}{y^9}$

5. **a)** x^5y^6 **b)** $108m^{12}$ **c)** $25x^4$ **d)** $\frac{4u^2}{v^2}$

A-4 The Pythagorean Theorem, pp. 534–535

1. **a)** $x^2 = 6^2 + 8^2$ **b)** $c^2 = 13^2 + 6^2$ **c)** $9^2 = y^2 + 5^2$ **d)** $8.5^2 = a^2 + 3.2^2$

2. **a)** 10 cm **b)** 11.5 cm **c)** 7.5 cm **d)** 7.9 cm

3. **a)** 13.93 **b)** 6 **c)** 23.07 **d)** 5.23

4. **a)** 11.2 m **b)** 6.7 cm **c)** 7.4 cm **d)** 4.9 m

5. 10.6 cm

6. 69.4 m

A-5 Evaluating Algebraic Expressions and Formulas, p. 536

1. **a)** 28 **b)** -17 **c)** 1 **d)** $\frac{9}{20}$

2. **a)** $\frac{1}{6}$ **b)** $\frac{5}{6}$ **c)** $\frac{-17}{6}$ **d)** $\frac{-7}{12}$

3. **a)** 82.35 cm^2 **b)** 58.09 m^2 **c)** 10 m **d)** 4849.05 cm^3

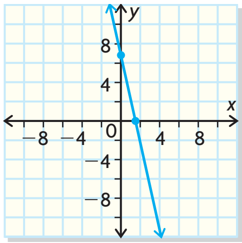
A-6 Finding Intercepts of Linear Relations, p. 538

1. **a)** x-int: 3, y-int: 1 **b)** x-int: -7, y-int: 14 **c)** x-int: 6, y-int: -3 **d)** x-int: 3, y-int: 5 **e)** x-int: -10, y-int: 10 **f)** x-int: $-\frac{15}{2}$, y-int: 3

2. **a)** x-int: 7, y-int: -7 **b)** x-int: -3, y-int: 2 **c)** x-int: -3, y-int: 12 **d)** x-int: -10, y-int: 6 **e)** x-int: -7, y-int: $\frac{7}{2}$ **f)** x-int: 2, y-int: $-\frac{12}{5}$

3. **a)** x-int: 13
b) y-int: -6
c) x-int: 7
d) x-int: -10
e) y-int: $-\frac{3}{2}$
f) y-int: 8

4. **a)** x-int: 1.5, y-int: 6.75
b)

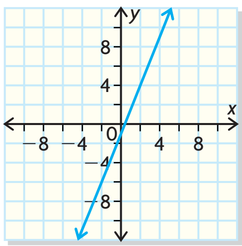


c) The foot of the ladder is on the ground 1.5 from the wall and the top of the ladder is 6.75 up the wall.

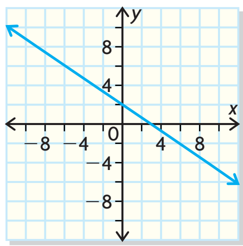
A-7 Graphing Linear Relationships, p. 540

1. **a)** $y = 2x + 3$
b) $y = \frac{1}{2}x - 2$
c) $y = -\frac{1}{2}x + 2$
d) $y = 5x + 9$

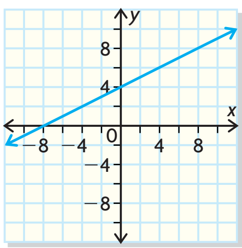
2. **a)**



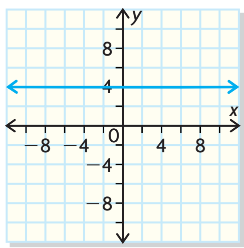
c)



b)

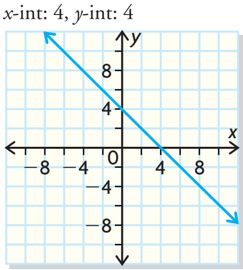


d)

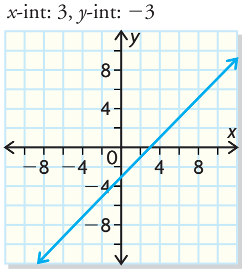


3. **a)** x-int: 10, y-int: 10
b) x-int: 8, y-int: 4
c) x-int: 5, y-int: 50
d) x-int: 2, y-int: 4

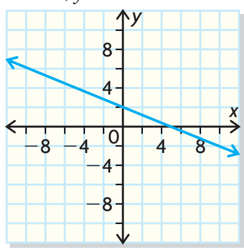
4. **a)** x-int: 4, y-int: 4



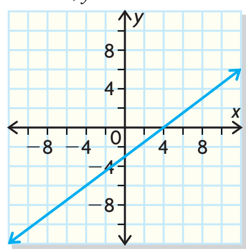
b) x-int: 3, y-int: -3



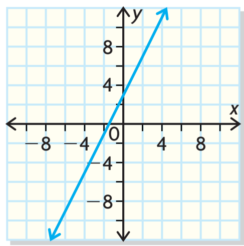
c) x-int: 5, y-int: 2



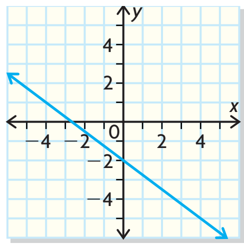
d) x-int: 4, y-int: -3



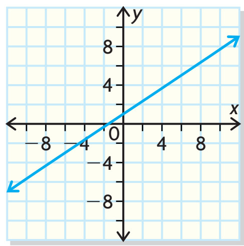
5. **a)**



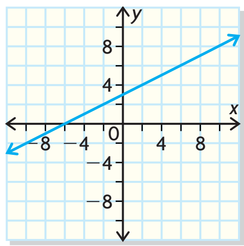
c)



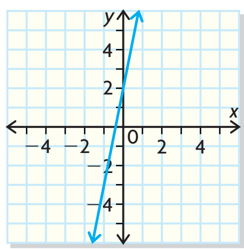
b)



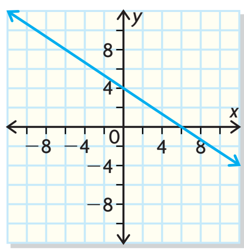
d)



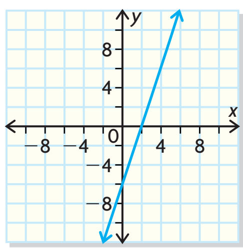
6. **a)**



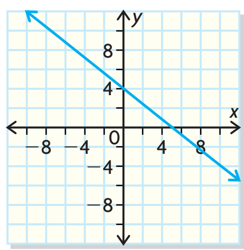
c)



b)

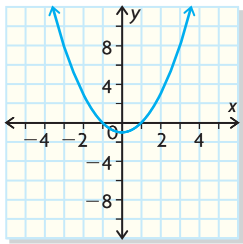


d)



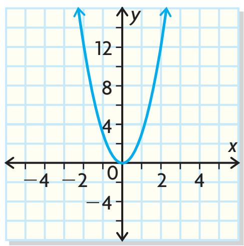
A-8 Graphing Quadratic Relations, p. 542

1. a)



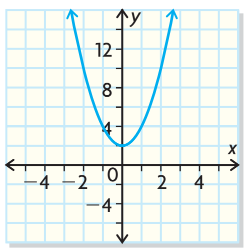
i) (0, −1) **ii)** $x = 0$ **iii)** −1 **iv)** −1, 1

b)



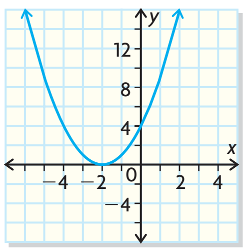
i) (0, 0) **ii)** $x = 0$ **iii)** 0 **iv)** 0

c)



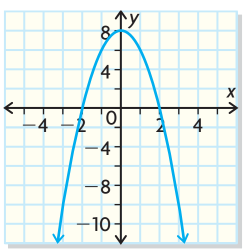
i) (0, 2) **ii)** $x = 0$ **iii)** 2 **iv)** none

d)



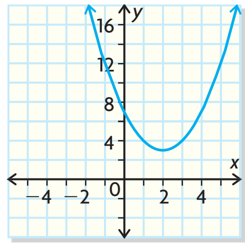
i) (−2, 0) **ii)** $x = -2$ **iii)** 4 **iv)** −2

e)



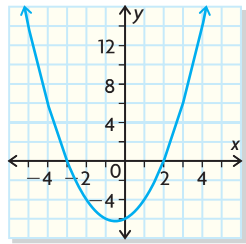
i) (0, 8) **ii)** $x = 0$ **iii)** 8 **iv)** −2, 2

f)



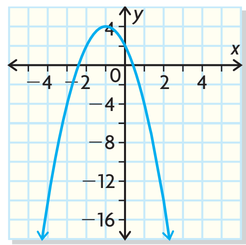
i) (2, 3) **ii)** $x = 2$ **iii)** 7 **iv)** none

g)



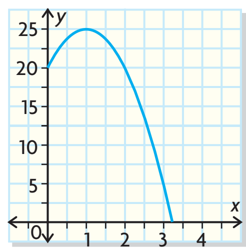
i) (−0.5, −6.25) **ii)** $x = -0.5$ **iii)** −6 **iv)** −3, 2

h)



i) (−1, 4) **iii)** 2
ii) $x = -1$ **iv)** $-1 + \sqrt{2}, -1 - \sqrt{2}$

2. a)



b) 25 m; 1 m
c) the height of the cliff
d) $1 + \sqrt{5}, 1 - \sqrt{5}$; The negative x-intercept represents a negative time, which is not possible. The positive x-intercept represents the time when then stone hits the ground.

A-9 Expanding and Simplifying Algebraic Expressions, p. 543

1. a) $-2x - 5y$ **c)** $-9x - 10y$
b) $11x^2 - 4x^3$ **d)** $4m^2n - p$
2. a) $6x + 15y - 6$ **c)** $3m^4 - 2m^2n$
b) $5x^3 - 5x^2 + 5xy$ **d)** $4x^7y^7 - 2x^6y^8$
3. a) $8x^2 - 4x$ **c)** $-13m^5n - 22m^2n^2$
b) $-34h^2 - 23h$ **d)** $-x^2y^3 - 12xy^4 - 7xy^3$
4. a) $12x^2 + 7x - 10$ **c)** $20x^2 - 23xy - 7y^2$
b) $14 + 22y - 12y^2$ **d)** $15x^6 - 14x^3y^2 - 8y^4$

Answers

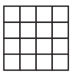
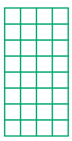
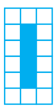
A-10 Factoring Algebraic Expressions, p. 545

1. **a)** $a(b + 2)$ **c)** $3y(1 - 3x)$ **e)** $11b^2(7b + 5)$
   b) $2(2x + 3)$ **d)** $a(7 + a)$ **f)** $3a(7 + 2b - 5a)$
2. **a)** $(x - 1)^2$ **c)** $(x - 7)(x + 4)$ **e)** $3(a + 1)^2$
   b) $(a + 1)(a + 2)$ **d)** $(z - 4)(z + 2)$ **f)** $5(x - 3)(x + 1)$
3. (a), (c), (e)
4. **a)** $(x - 9)(x + 9)$ **c)** $(2a - 1)(2a + 1)$ **e)** $369 - 4x^2$
   b) $2(2 - 9z^2)$ **d)** $16(x - 1)(x + 1)$ **f)** $16(25 - xy)$

A-11 Solving Linear Equations Algebraically, p. 546

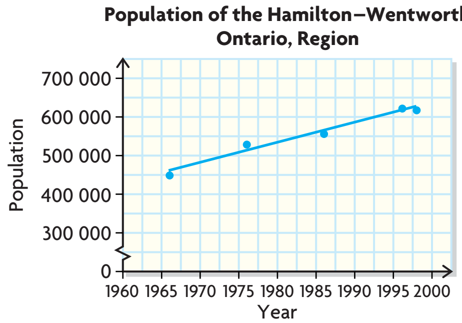
1. **a)** $x = 9$ **c)** $m = 3$ **e)** $y = 6$
   b) $x = 0.8$ **d)** $m = -4$ **f)** $r = \frac{23}{10}$
2. **a)** $x = 100$ **c)** $m = \frac{2}{3}$ **e)** $y = \frac{7}{18}$
   b) $x = 20$ **d)** $y = 21$ **f)** $m = -\frac{6}{5}$
3. **a)** 6 cm **b)** 16 m
4. 147 student and 62 adult

A-12 Pattern Recognition and Difference Tables, pp. 547–548

1. **a) i)**  **ii)** 1, 3, 5, 7 **iii)** 9
   b) i)  **ii)** 1, 4, 9, 16 **iii)** 25
   c) i)  **ii)** 2, 4, 6, 8 **iii)** 10
   d) i)  **ii)** 1, 4, 9, 16 **iii)** 25
   e) i)  **ii)** 2, 8, 18, 32 **iii)** 50
   f) i)  **ii)** 8, 10, 12, 14 **iii)** 16
2. **a) i)** 4, 10, 16, 22 **ii)** 28
   b) i) 4, 12, 24, 40 **ii)** 60
   c) i) 7, 13, 19, 25 **ii)** 31
   d) i) 3, 9, 18, 30 **ii)** 45
   e) i) 7, 22 ,45, 72 **ii)** 115
   f) i) 24, 30, 36, 42 **ii)** 48
3. **a) i)** linear **ii)** 17
   b) i) quadratic **ii)** -301
   c) i) quadratic **ii)** -0.4
   d) i) linear **ii)** 565
4. **a)** Constant difference is -1; linear
   b) Second constant difference of 2; quadratic
5. Constant difference of \$6; linear
6. **a)** 13 **b)** -100 **c)** $\frac{43}{24}$ **d)** 4.8

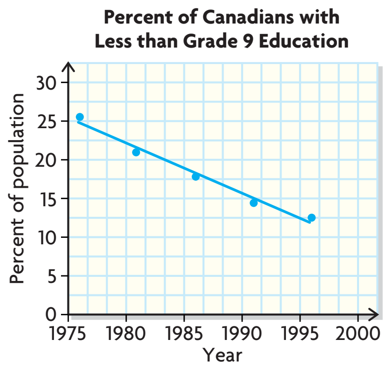
A-13 Creating Scatter Plots and Lines or Curves of Good Fit, p. 550

1. **a) i)**



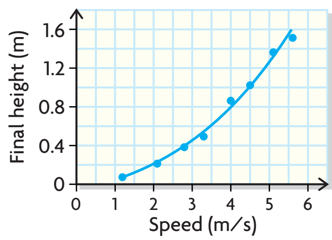
   ii) The data display a strong positive correlation.

   b) i)



   ii) The data display a strong negative correlation.

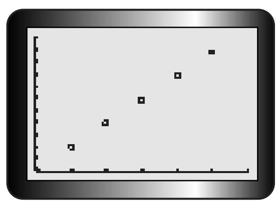
2. **a)**



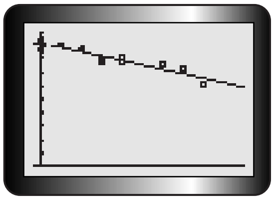
   b) The motion sensor's measurements are consistent since the curve goes through several of the points.

A-14 Interpolating and Extrapolating, p. 553

1. **a)** 53 m, 54 m **b)** 73 m, 77 m
2. **a)**



   b) 24.5 m/s ; 34.3 m/s; 46.55 m/s
   c) 58.8 m/s; 88.2 m/s; 98 m/s
3. Extrapolation is a prediction based on the data, while interpolation is taken directly from the data.

4. **a)** 

b) The average for 0 absences is 90%. For every time absent, the average mark drops by about 3%.

c) 72%

d) 13 days absent

5. 82 m; 24 m/s

A-15 Trigonometry of Right Triangles, p. 557

1. 27 m

2. **a)** $\sin A = \frac{12}{13}, \cos A = \frac{5}{13}, \tan A = \frac{12}{5}$

b) $\sin A = \frac{4}{5}, \cos A = \frac{3}{5}, \tan A = \frac{4}{3}$

c) $\sin A = \frac{8}{17}, \cos A = \frac{15}{17}, \tan A = \frac{8}{15}$

d) $\sin A = \frac{3}{5}, \cos A = \frac{4}{5}, \tan A = \frac{3}{4}$

3.	**a)** 4.4	**b)** 6.8	**c)** 5.9	**d)** 26.9
4.	**a)** 39°	**b)** 54°	**c)** 41°	**d)** 65°
5.	**a)** 12.5 cm	**b)** 20.3 cm	**c)** 19.7 cm	**d)** 24°
6.	**a)** 12.4	**b)** 5.7	**c)** 27°	**d)** 46°

7. 8.7 m

8. 84.2 m

9. 195 m

Answers