Answers

Chapter 1

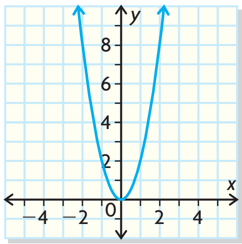
Getting Started, pp. 2–4

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

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

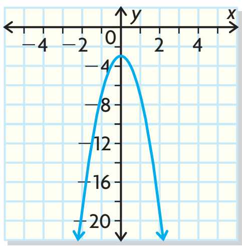
3. **a)**

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



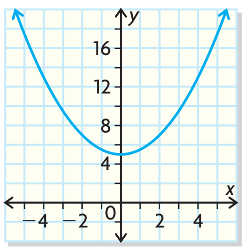
b)

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



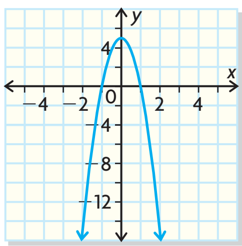
c)

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

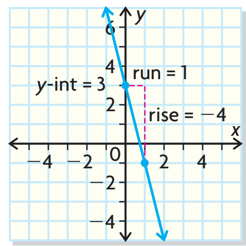
6. **a)** Yes. When I substitute 2 for x and -1 for y into $2x - y$, the equation $2x - y = 5$ is true.
b) No. When I substitute -1 for x and 29 for y, the equation $y = -2x^2 - 5x + 22$ is false.

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

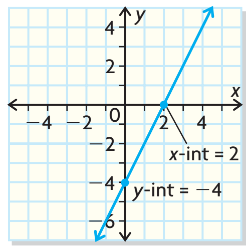
8. **a)** $2; x = 0$ **b)** $-4; x = 0$

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

10. **a)**

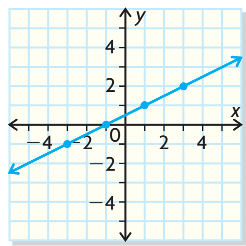


b)

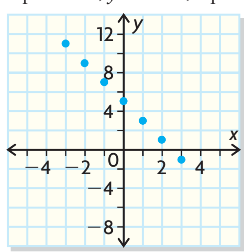


c)

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



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



12.

Definition:	**Characteristics:**
A quadratic relations is a relation that can be described by an equation that contains a polynomial whose highest degree is 2.	• axis of symmetry • single maximum or minimum value
Quadratic Relation	
Examples:	**Non-examples:**
$y = x^2 + 7x + 10$ $y = x^2 - 8x + 7$	$y = 4x + 3$ $y = x^3 - 1$

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

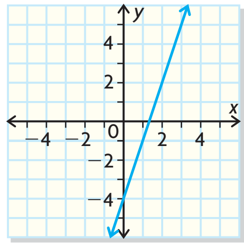
4. **a)** Function since there is only one y-value for each x-value.
b) Not a function since there are two y-values for $x = 1$.
c) Function since there is only one y-value for each x-value.
d) Not a function since there are two y-values for $x = 1$.

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

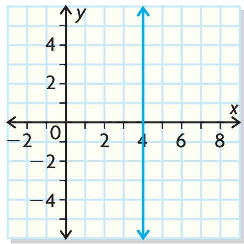
6. **a)** Function since a vertical line will pass through only one y-value for any x-value.
D = {0, 1, 2, 3, 4}, R = {2, 4, 6, 8, 10}
b) Not a function since a vertical line passes through two points at $x = 0$ and $x = 1$.
D = {0, 1, 2}, R = {2, 4, 6, 8, 10}
c) Not a function since a vertical line 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.
$D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq 1\}$
b) Not a function since a vertical line passes through two points at several values of x.
$D = \{x \in \mathbf{R} \mid x \geq 1\}$, $R = \{y \in \mathbf{R}\}$
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.
$D = \{x \in \mathbf{R} \mid -3 \leq x \leq 3\}$, $R = \{y \in \mathbf{R} \mid -3 \leq y \leq 3\}$

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,

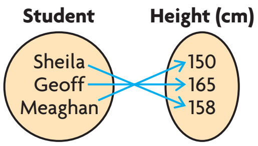
Definition:
A function is a relation in which there is only one y-value (the dependent variable) for every x-value (the independent variable).

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.

Function

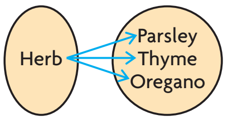
Examples:

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) $D = \{t \mid 0 \le t \le 0.8, t \in \mathbf{R}\}$, $R = \{d \mid 0 \le d \le 0, d \in \mathbf{R}\}$

2. a) $f(x) = 60x$

b) The degree is 1. The function is linear.

c) \$1800

d) $D = \{x \mid 0 \le x \le 60, x \in \mathbf{W}\}$, $R = \{f(x) \mid 0 \le f(x) \le 3600, f(x) \le \mathbf{W}\}$

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.

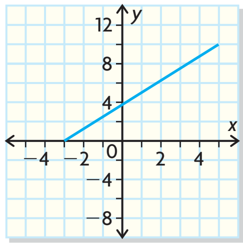
5.

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

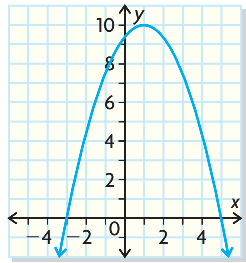
Based on the data given and the differences, the data are neither linear nor quadratic.

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

7. a)



b)



8. a) $f(t) = 29.4t - 4.9t^2$

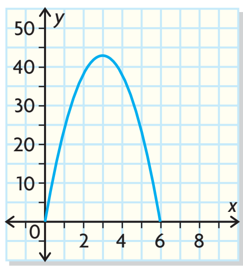
b) The degree is 2, so the function is quadratic.

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.

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.

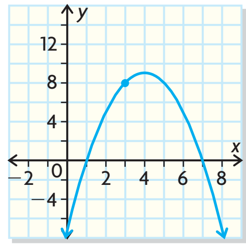
14. **a)**

Fertilizer, *x* (kg/ha)	0	0.25	0.50	0.75	1.00
Yield, *y*(*x*) (tonnes)	0.14	0.45	0.70	0.88	0.99

Fertilizer, *x* (kg/ha)	1.25	1.50	1.75	2.00
Yield, *y*(*x*) (tonnes)	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.

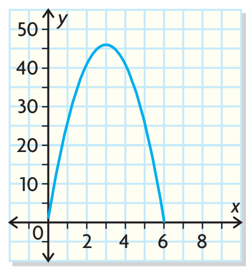
17. **a)**

Time (s)	0	0.5	1	1.5	2	2.5	3
Height (m)	1	14.75	26	34.75	41	44.75	46

Time (s)	3.5	4	4.5	5	5.5	6
Height (m)	44.75	41	34.75	26	14.75	1

Time (s)	6.5	7	7.5	8
Height (m)	-15.25	-34	-55.25	-79

b)



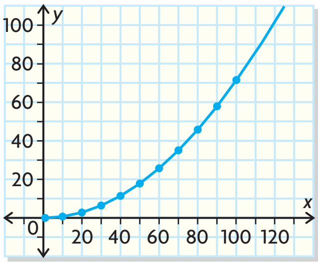
c) 3 s
d) 46 m
e) about 6.1 s

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

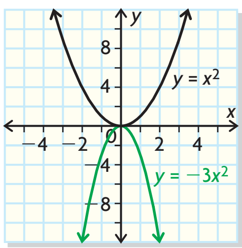
Lesson 1.4, p. 40

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

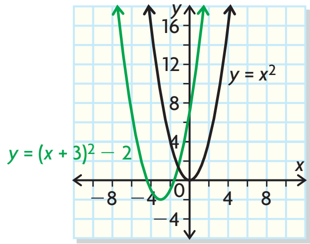
1. a) (vi) because it opens down and the vertex is at $(2, -3)$
   b) (iv) because it opens down and the vertex is at $(0, -4)$
   c) (i) because it opens up and the vertex is at $(0, 5)$
   d) (v) because it opens up and the vertex is at $(-2, 0)$
   e) (iii) because it opens up and the vertex is at $(2, 0)$
   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



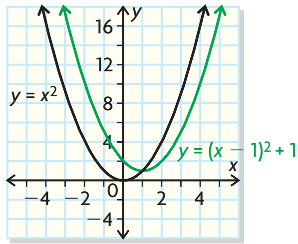
   b) $a = 1, h = -3, k = -2$; opens up, move 3 units to the left and 2 units down

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



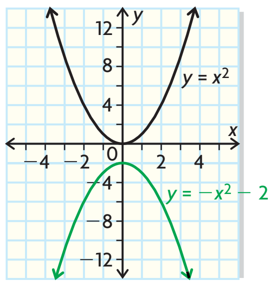
   c) $a = 1, h = 1, k = 1$; opens up, move 1 unit to the right and 1 unit up

x	y
−3	17
−2	10
−1	5
0	2
1	1
2	2
3	5



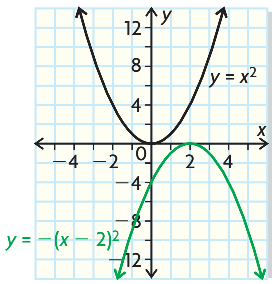
   d) $a = -1, h = 0, k = -2$; opens down, move 2 units down

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



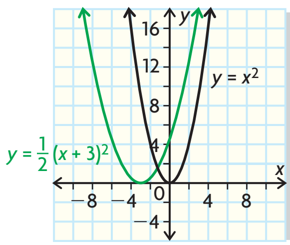
   e) $a = -1, h = 2, k = 0$; opens down, move 2 units to the right

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



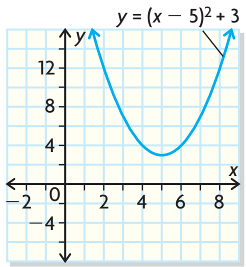
f) $a = \frac{1}{2}$; $h = -3$, $k = 0$; opens up, move 3 units to the left, and vertically compress by a factor of 2

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

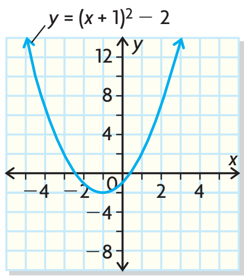


3. **a)** (iv) **b)** (i) **c)** (iii) **d)** (ii)

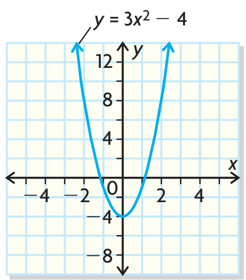
4. **a)** Move 5 units to the right and 3 units up.



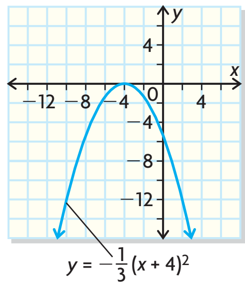
b) Move 1 unit to the left and 2 units down.



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)** $y = 5x^2$ **b)** $y = \frac{1}{2}x^2$ **c)** $y = -(x - 2)^2$ **d)** $-\frac{1}{3}x^2 + 2$

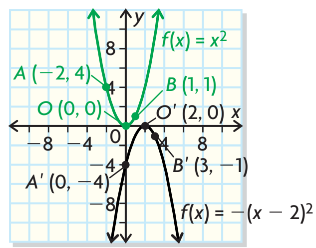
6. **a)** $y = (x - 2)^2 - 6$ **b)** $y = (x + 2)^2 - 4$ **c)** $y = x^2 - 1$ **d)** $y = (x - 5)^2 - 5$

7. **a)** $y = x^2 + 4$ **b)** $y = (x - 5)^2$ **c)** $y = -(x - 5)^2$ **d)** $y = 2(x - 2)^2$ **e)** $y = -0.5(x + 2)^2$ **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 $x = 2$.

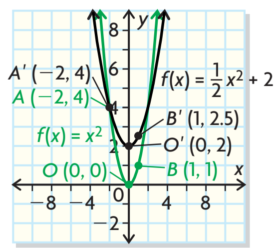
iii), iv)



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 $x = 0$.

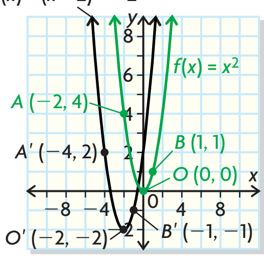
iii), iv)



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)



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.

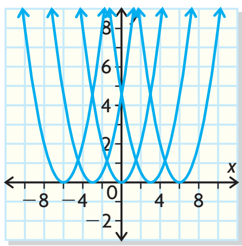
d) The x-coordinates are unchanged and the y-coordinates are multiplied by $-\frac{1}{2}$ and decreased by 4.

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

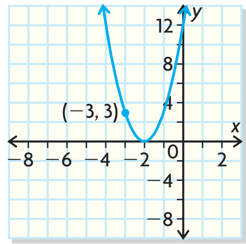
1. a) horizontal translation 2 units to the left and vertical stretch by a factor of 3

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

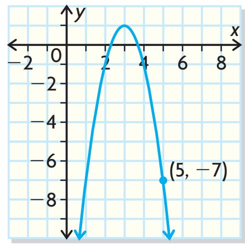
d) horizontal translation 2 units to the left, reflection in x-axis, vertical compression by a factor of 2, and vertical translation 4 units up

2. a)



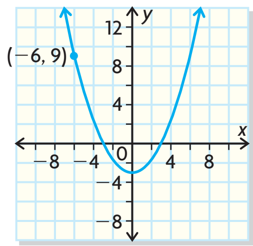
$f(-3) = 3(-3 + 2)^2 = 3(-1)^2 = 3$

b)



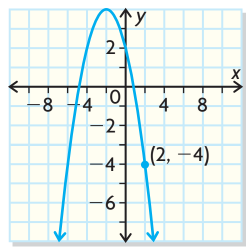
$f(5) = -2(5 - 3)^2 + 1 = -2(2)^2 + 1 = -7$

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; $y = -(x + 4)^2 - 2$

Answers

5. a) $y = 2(x - 4)^2 - 1$ d) $y = \frac{1}{2}(x - 2)^2 - 2$

b) $y = -\frac{1}{3}(x + 2)^2 + 3$ e) $y = -2(x + 1)^2 + 4$

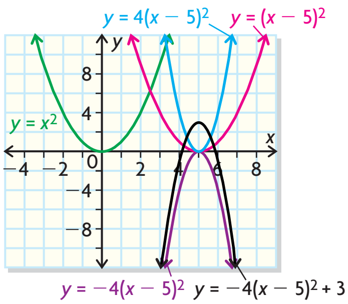
c) $y = -\frac{1}{2}(x + 3)^2 + 2$ f) $y = (x - 4)^2 + 5$

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

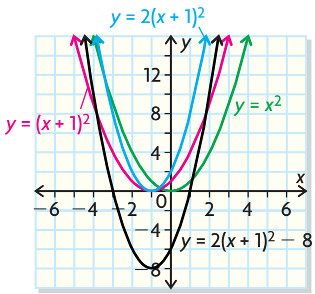
b) $y = \frac{1}{2}(x - 2)^2 - 4$ e) $y = -(x - 4)^2 - 8$

c) $y = x^2 - 4$

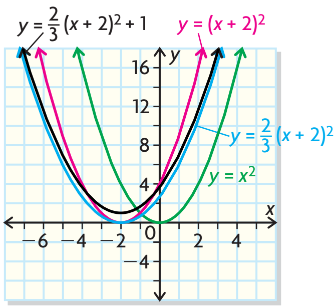
7. a) horizontal translation 5 units to the right, vertical stretch by a factor of 4, vertical reflection in the x-axis, and vertical translation 3 units up



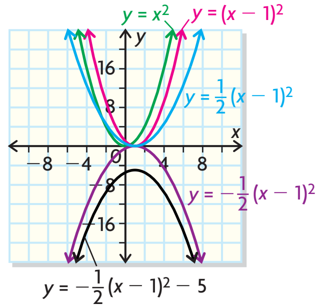
b) horizontal translation 1 unit to the left, vertical stretch by a factor of 2, and vertical translation 8 units down



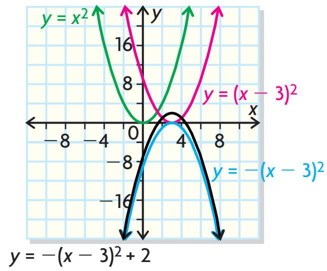
c) horizontal translation 2 units to the left, vertical compression by a factor of $\frac{3}{2}$, and vertical translation 1 unit up



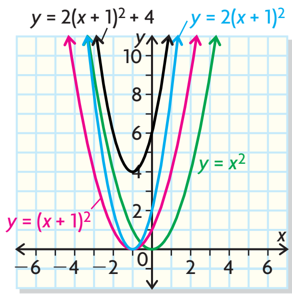
d) horizontal translation 1 unit to the right, vertical compression by a factor of 2, vertical reflection in x-axis, and vertical translation 5 units down



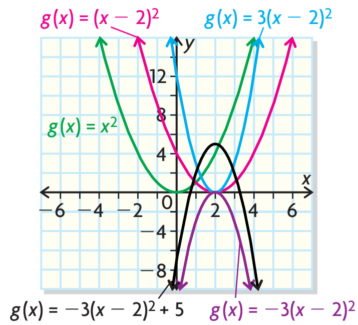
e) horizontal translation 3 units to the right, vertical reflection in the x-axis, and vertical translation 2 units up



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

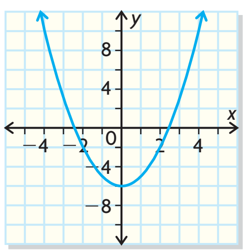
2. a) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \leq 5\}$; $f(x)$ is a quadratic function that opens down and the vertex is at $(-3, 5)$, which is a maximum.
b) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \geq 5\}$; $f(x)$ is a quadratic function that opens up and the vertex 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. $D = \{t \in \mathbf{R} \mid 0 \leq t \leq 20\}, R = \{f(t) \in \mathbf{R} \mid 0 \leq f(t) \leq 500\}$; 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) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \leq 2\}$
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) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \geq -4\}$
f) $D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R}\}$

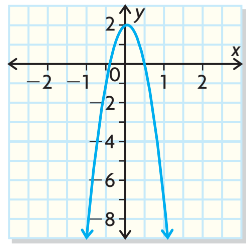
5. $D = \{x \in \mathbf{R} \mid 1 \leq x \leq 11\}, R = \{y \in \mathbf{R} \mid 12 \leq y \leq 36\}$

6. a)



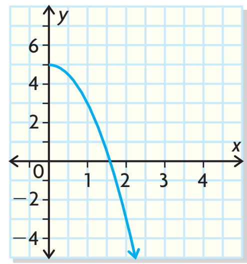
$D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \geq -6\}$

b)



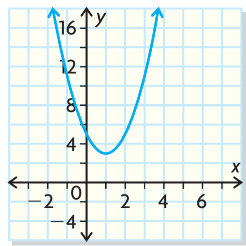
$D = \{x \in \mathbf{R}\}, R = \left\{y \in \mathbf{R} \mid y \leq \frac{81}{40}\right\}$

c)



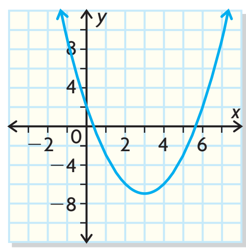
$D = \{x \in \mathbf{R} \mid x \geq 0\}, R = \{y \in \mathbf{R} \mid y \leq 5\}$

d)



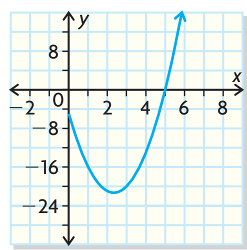
$D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \geq 3\}$

e)

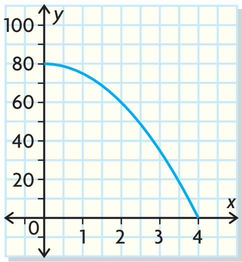


$D = \{x \in \mathbf{R}\}, R = \{y \in \mathbf{R} \mid y \geq -7\}$

f)



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

7. **a)** 

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

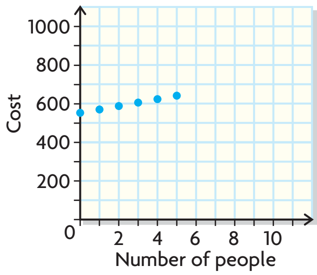
c) The bridge is 80 m high since the maximum height of 80 m occurs when $t = 0$ s, when the pebble is dropped.

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



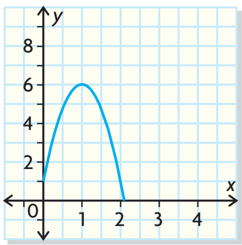
b) $C(n) = 550 + 18n$

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.

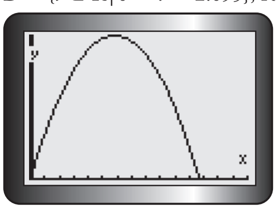
c) 6 m

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)** $f(-1) = 7$

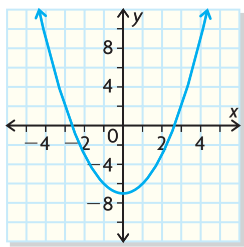
b) $f(3) = 19$

c) $f(0.5) = 0.25$

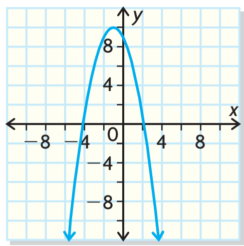
5. **a)** 5 **c)** 31

b) 4 **d)** 4

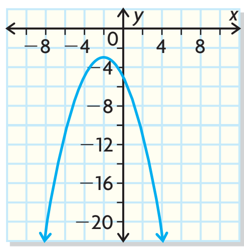
6. **a)** vertex at $(0, -7)$, $x = 0$, opens up



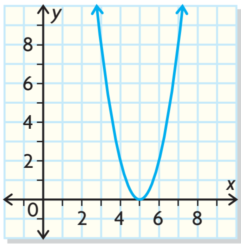
b) vertex at $(-1, 10)$, $x = -1$, opens down



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



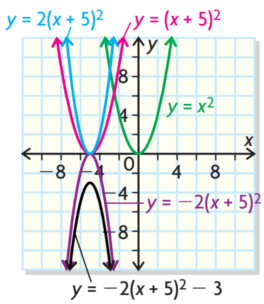
d) vertex at (5, 0), $x = 5$, opens up



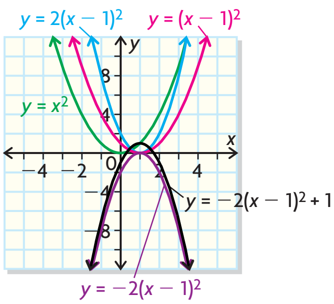
7. **a)** vertical translation 7 units down
b) horizontal translation 1 unit to the left, vertical reflection in x-axis, and vertical translation 10 units up
c) horizontal translation 2 units to the left, vertical compression by a factor of 2, vertical reflection in x-axis, and vertical translation 3 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)** $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} | y \geq -4\}$
ii) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} | y \geq 0\}$
iii) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} | y \geq -7\}$

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

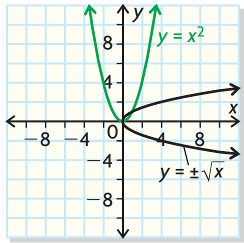
13. **a)** 57 m
b) 6.4 s
c) $D = \{t \in \mathbf{R} | 0 \leq t \leq 6.4\}$, $R = \{h(t) \in \mathbf{R} | 0 \leq h(t) \leq 57\}$

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.

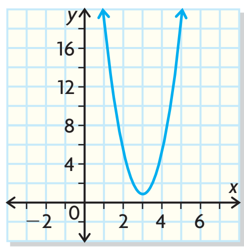
Time (s)	0	1	2	3	4	5
Height (m)	0	30	40	40	30	0
First Differences	30	10	0	−10	−30	
Second Differences	−20	−10	−10	−20		

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

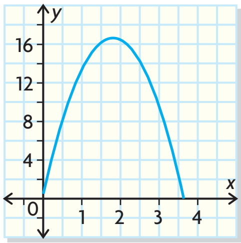
4. **a)** $f(2) = 3(2)^2 - 2(2) + 6 = 14$
b) $f(x - 1) = 3(x - 1)^2 - 2(x - 1) + 6 = 3x^2 - 8x + 11$

5. **a)** 28
b) the y-coordinate when the x-coordinate is 1
c) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} | y \geq 1\}$
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) $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} | y \geq 1\}$
d)



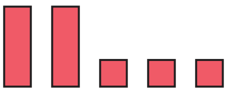
Answers

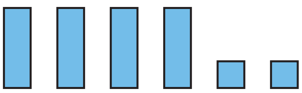
7. a) 

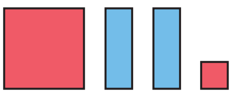
b) t represents time, which can never be negative.
c) 16.7 m
d) 1.8 s
e) 3.6 s
f) $D = \{t \in \mathbf{R} \mid 0 \leq t \leq 3.6\}$, $R = \{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 16.7\}$

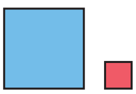
Chapter 2

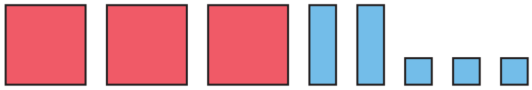
Getting Started, pp. 74–76

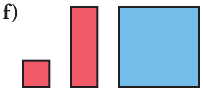
1. a) (vii) c) (viii) e) (i) g) (ii)
   b) (iv) d) (vi) f) (iii) h) (v)
2. a) $-6x + y$ c) $3x - 3y + 3$
   b) xy d) $-9a - 7b - 7ab$
3. a) x^5 b) $10x^3$ c) x^2 d) $2x^2$
4. a) $(x)(x) = x^2$ b) $(2x)(4x) = 8x^2$
5. a) $9x - 24$ d) $-5d^3 - 11d^2 - 6d + 36$
   b) $-32x^2 + 8x - 4$ e) $6x^3 + 10x^2$
   c) $14x^2 - 10x + 8$ f) $-5x^4 + 15x^3 - 20x^2$
6. a) $2(x - 5)$ c) $5(5x^2 + 4x - 20)$
   b) $6(x^2 + 4x + 5)$ 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) c) (iii)
   b) (ii), (iv), and (vi) d) (iii) and (iv)
9. a) 8 c) 18 e) $3x + 2$
   b) 8 d) x f) $5x$
10. a) $2 \times 3 \times 13$ b) 7×3^2 c) $5^2 \times 11^2$ d) 41
11. a) 

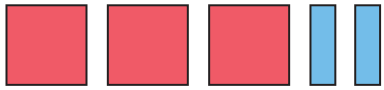
b) 

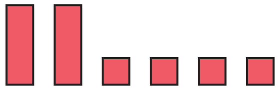
c) 

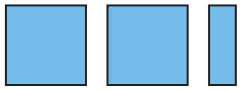
d) 

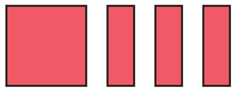
e) 

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) $x^2 + 4x - 21$ c) $4x^2 - 20x + 25$
   b) $a^2 + 12a + 36$ d) $m^2 - 81$
3. a) $3x^2 - 3x - 90$ c) $-3n^2 + 2n + 4$
   b) $a^2 - 2a + 7$ 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) $12x^2 + 7x - 10$ d) $4a^2 + 29a + 32$
   b) $45x^2 + 60x + 20$ e) $-20n^2 - 2n$
   c) $-14x^2 - 12x + 19$ f) $4x^2 + 75$
6. a) 11 c) $-2x^2 - x + 6$
   b) -2 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