Lesson 4.1   **Writing Equations to Describe Patterns**   Practice (pages 154–162)

Check

4. Substitute $n = 1$ in each equation.
   a) $P = 2n$
      $= 2(1)$
      $= 2$

   b) $P = 3n$
      $= 3(1)$
      $= 3$

   c) $P = 4n$
      $= 4(1)$
      $= 4$

   d) $P = 5n$
      $= 5(1)$
      $= 5$

5. Substitute $n = 2$ in each equation.
   a) $A = 3n + 1$
      $= 3(2) + 1$
      $= 6 + 1$
      $= 7$

   b) $A = 3n + 2$
      $= 3(2) + 2$
      $= 6 + 2$
      $= 8$

   c) $A = 3n + 3$
      $= 3(2) + 3$
      $= 6 + 3$
      $= 9$

   d) $A = 3n + 4$
      $= 3(2) + 4$
      $= 6 + 4$
      $= 10$

6. To determine which equations might represent the pattern, substitute into each equation to see which equation is true when $P = 3$ and 1 $n = 1$.

   a) $P = 3n$
      Left side = 3   Right side = 3(1)
                                = 3
      This equation is true

   b) $P = n + 3$
      Left side = 3   Right side = 1 + 3
                                = 4
      This equation is false

   c) $P = 2n + 1$
      Left side = 3   Right side = 2(1) + 1
                                = 3
      This equation is true

   d) $P = 3 - n$
      Left side = 3   Right side = 3 – 1
                                = 2
      This equation is false

   The equations in parts a and c might represent the pattern.

7. As the figure number increases by 1, the number of squares increases by 1.
   The number of squares for figure 1 is $6 = 1 + 5$.
   This suggests that we add 5 to the figure number, so the number of squares in figure f is: $f + 5$.

   Use figure 2 to check. Since $f = 2$, the number of squares should be $2 + 5 = 7$, which is correct.
   So, expression c, $f + 5$, represents the number of squares in terms of the figure number.

8. Create a table.

Size Number, s	Number of Squares, n
1	5
2	9
3	13

   As the size number increases by 1, the number of squares increases by 4. This suggests that the number of squares may be four times the size number. So, the equation $n = 4s$ may represent the relationship.

Check whether $n = 4s$ is correct.
When $s = 1$, $n = 4(1)$
$= 4$
This is 1 less than the number 5 in the table. So, we add 1 to $4s$ to describe the number of squares correctly. The expression $4s + 1$ represents the number of squares for any size number s.
An equation is: $n = 4s + 1$.

Verify the equation by substituting values of s and n from the table.
Substitute $s = 2$ and $n = 9$ into the equation $n = 4s + 1$.
Left side $= 9$ Right side $= 4s + 1$
$= 4(2) + 1$
$= 8 + 1$
$= 9$
Since the left side equals the right side, the equation is verified.
So, equation c, $n = 4s + 1$, relates the number of squares to the number size.

9. As the figure number increases by 1, the number of squares increases by 2. This suggests that the number of squares may be two times the size number. So, the equation $s = 2f$ may represent the relationship.

Check whether $s = 2f$ is correct.
When $f = 1$, $s = 2(1)$
$= 2$
This is 3 less than the number 5 in the table. So, we add 3 to $2f$ to describe the number of squares correctly. The expression $2f + 3$ represents the number of squares for any figure number f.
An equation is: $s = 2f + 3$.

Verify the equation by substituting values of f and s from the table.
For example, substitute $f = 2$ and $s = 7$ into the equation $s = 2f + 3$.
Left side $= 7$ Right side $= 2f + 3$
$= 2(2) + 3$
$= 4 + 3$
$= 7$
Since the left side equals the right side, the equation is verified.
So, equation b, $s = 2f + 3$, relates the number of squares to the figure number.

10. a) To build one house, we start with 1 toothpick then add 4 toothpicks. To build 2 houses, we start with 1 toothpick then add two sets of 4 toothpicks. This pattern continues.

b) We write the pattern as: 1 + (number of houses) × 4. To build n houses, we start with 1 toothpick then add n sets of 4 toothpicks. So, an expression for the number of toothpicks in n houses is: $1 + 4n$.

c) When t represents the number of toothpicks, then the total number of toothpicks in n houses is given by the equation $t = 1 + 4n$.

d) Substitute values of n in the equation $t = 1 + 4n$.
When $n = 1$, $t = 4(1) + 1$
$= 5$
When $n = 2$, $t = 4(2) + 1$
$= 9$
When $n = 3$, $t = 4(3) + 1$
$= 13$
When $n = 4$, $t = 4(4) + 1$
$= 17$
These four values match the first four pictures in the pattern so the equation is verified.

Apply

11. a) i) As the term number, *t*, increases by 1, the term value, *v*, increases by 11. The value of *v* when *t* = 1 is 11(1) = 11. The term value is eleven times the term number.

   ii) An expression for *v* in terms of *t* is: 11*t*

   iii) An equation is: *v* = 11*t*

   iv) Substitute *t* = 2 and *v* = 22 in the equation *v* = 11*t*

   Left side = 22   Right side = 11(2)

                                      = 22

   Since the left side equals the right side, the equation is verified.

   b) i) As the term number, *t*, increases by 1, the term value, *v*, increases by 3. The value of *v* when *t* = 1 is 3(1) + 2 = 5. The term value is three times the term number, plus two.

   ii) An expression for *v* in terms of *t* is: 3*t* + 2

   iii) An equation is: *v* = 3*t* + 2

   iv) Substitute *t* = 2 and *v* = 8 in the equation *v* = 3*t* + 2

   Left side = 8   Right side = 3(2) + 2

                                   = 6 + 2

                                   = 8

   Since the left side equals the right side, the equation is verified.

   c) i) As the term number, *t*, increases by 1, the term value, *v*, decreases by 1. The value of *v* when *t* = 1 is 8 − 1(1) = 7. The term value is eight subtract the term number.

   ii) An expression for *v* in terms of *t* is: 8 − 1*t*, or 8 − *t*

   iii) An equation is: *v* = 8 − 1*t*, or *v* = 8 − *t*

   iv) Substitute *t* = 2 and *v* = 6 in the equation *v* = 8 − *t*

   Left side = 6   Right side = 8 − 2

                                   = 6

   Since the left side equals the right side, the equation is verified.

12. a)

Figure Number, *n*	Number of Toothpicks, *t*
1	3
2	5
3	7
4	9

As the figure number increases by 1, the number of toothpicks increases by 2.

b) Each figure needs 1 toothpick for the left edge, plus 2 additional toothpicks for each triangle in the figure. That is, number of toothpicks = 1 + (figure number) × 2. An expression is: 1 + 2*n*, or 2*n* + 1

c) Substitute *n* = 45 in the expression 2*n* + 1.

   2(45) + 1 = 90 + 1

              = 91

   There are 91 toothpicks in figure 45

d) An equation is: *t* = 2*n* + 1

e) Substitute $t = 17$ in the equation $t = 2n + 1$, then solve for n.

$17 = 2n + 1$ Subtract 1 from each side.

$17 - 1 = 2n + 1 - 1$

$16 = 2n$ Divide both sides by 2.

$$\frac{16}{2} = \frac{2n}{2}$$

$8 = n$

Figure 8 has 17 toothpicks.

I could check my answer by substituting $t = 17$ and $n = 8$ in the equation $t = 2n + 1$.

Left side = 17   Right side = $2(8) + 1$

                                  = 17

Since the left side equals the right side, the answer is correct.

13. a)

Number of Tables, n	Number of People, p
1	6
2	10
3	14
4	18

b) As the number of tables increases by 1, the number of people who can be seated increases by 4.

c) I can develop a pattern.

Since the number of people increases by 4 each time, I know I have to multiply the number of tables by 4 and then find out what I need to add or subtract to get the number of people.

From the table, when $n = 1$, $p = 6 = 4(1) + 2$, so I have to add 2 to get the number of people.

I can generalize this pattern by writing an expression or an equation.

d) When the number of people who can be seated is represented by p and the number of tables by n, then an equation is: $p = 4n + 2$.

To verify this equation, I substitute a pair of values of p and n in the equation to check that the left side is equal to the right side. I choose $n = 3$ and $p = 14$.

Substitute $n = 3$ and $p = 14$ in the equation $p = 4n + 2$:

Left side = 14   Right side = $4(3) + 2$

                                  = 14

Since the left side is equal to the right side, the equation is correct

e) Substitute $p = 41$ in the equation $p = 4n + 2$ and solve for n.

$41 = 4n + 2$ Subtract 2 from each side.

$41 - 2 = 4n + 2 - 2$

$39 = 4n$ Divide both sides by 4.

$$\frac{39}{4} = \frac{4n}{4}$$

$9.75 = n$

Since the number of tables cannot be a decimal, I would need 10 tables to seat 41 people.

I can check the answer by substituting $n = 10$ in the equation.

$p = 4(10) + 2$

   = 42

This means 41 people can be seated at 10 tables and my answer is correct.

14. a) The cost, *C* dollars, is $250 plus $1.25 × (number of brochures, *n*).
An equation is: *C* = 250 + 1.25*n*.

b) Substitute *n* = 2500 in the equation *C* = 250 + 1.25*n*.
C = 250 + 1.25(2500)
  = 250 + 3125.00
  = 3375.00
It costs $3375.00 to print 2500 brochures.

c) Substitute *C* = 625 in the equation *C* = 250 + 1.25*n*, then solve for *n*.
625 = 250 + 1.25*n*   Subtract 250 from each side.
625 – 250 = 250 + 1.25*n* – 250
$\dfrac{375}{1.25} = \dfrac{1.25n}{1.25}$ Divide both sides by 1.25.
300 = *n*
300 brochures can be printed for $625.

15. a)

Number of Toppings, *n*	Cost, *C* ($)
0	9.00
1	9.75
2	10.50
3	11.25
4	12.00
5	12.75

b) The cost of a pizza, *C*, is $9.00 plus $0.75 × (number of toppings, *n*).
So, an equation is *C* = 9.00 + 0.75*n*.

To verify the equation, substitute *n* = 3 in the equation *C* = 9.00 + 0.75*n*.
C = 9.00 + 0.75(3)
  = 9.00 + 2.25
  = 11.25
From the table, *C* = 11.25 when *n* = 3, so the equation is correct.

c) I used the equation. Substitute *C* = 15.00, then solve for *n*.
15.00 = 9.00 + 0.75*n*   Subtract 9.00 from each side.
15.00 – 9.00 = 9.00 + 0.75*n* – 9.00
6.00 = 0.75*n*   Divide both sides by 0.75.
$\dfrac{6.00}{0.75} = \dfrac{0.75n}{0.75}$
8 = *n*
The pizza has 8 toppings.

From the table, when the number of toppings increased from 0 to 4, the cost increased from $9 to $12, an increase of $3. The cost should increase another $3 to $15 when the number of toppings increases from 4 to 8 toppings.

16. a) The cost is $12 plus $1.50 × (number of windows cleaned). Let C represent the total cost in dollars and let w represent the number of windows cleaned, then an equation is $C = 12 + 1.50w$.
Substitute $w = 1$ into the equation:
$C = 12 + 1.50(1)$
$ = 13.50$
$13.50 is the cost to clean one window; so the equation is correct.

b) Substitute $C = 28.50$ into the equation, then solve for w.
$28.50 = 12 + 1.50w$
$28.50 - 12 = 12 + 1.50w - 12$
$ 16.50 = 1.50w$
$$\frac{16.50}{1.50} = \frac{1.50w}{1.50}$$
$ 11 = w$
Clint cleaned 11 windows.

I can verify this by substituting $w = 11$ into the equation.
$C = 1.50w + 12$
$ = 1.50(11) + 12$
$ = 16.50 + 12$
$ = 28.50$
Since this matches the given value of C, the answer is correct.

17. Let p represent the number of patio stones needed and let n represent the size number of the garden. Create a table.

Garden Size, n	Number of Patio Stones, p
1	8 = 2(1) + 6
2	10 = 2(2) + 6
3	12 = 2(3) + 6
4	14 = 2(4) + 6

As the garden size number increases by 1, the number of patio stones increases by 2. When the size number is 1, 8 patio stones are needed. So, an equation is $p = 2n + 6$.

To determine the garden size of a patio with 152 stones, substitute $p = 152$ into the equation $p = 2n + 6$, then solve for n.
$152 = 2n + 6$　　　　　Subtract 6 from each side.
$152 - 6 = 2n + 6 - 6$
$146 = 2n$　　　　　Divide both sides by 2.
$$\frac{146}{2} = \frac{2n}{2}$$
$73 = n$
The garden size is 73.

18. a) When there is 1 house, there are 5 toothpicks. For each additional house, 4 more toothpicks are added. For example, when there are 3 houses, there is 1 house with 5 toothpicks and 2 additional houses each with 4 toothpicks.

b) For n houses, there is 1 house with 5 toothpicks and $(n - 1)$ houses each with 4 toothpicks. So the number of toothpicks, t, in n houses is: $t = 5 + 4(n - 1)$.

c) Simplify this equation.

$t = 5 + 4(n - 1)$

$t = 5 + 4n - 4$

$t = 4n + 1$

This is the same equation as in question 10c. Two different equations can represent the same pattern because one has not been simplified. $t = 5 + 4(n - 1)$ simplifies to $t = 4n + 1$.

Take It Further

19. a) Let n represent the figure number, let P represent the perimeter, and let A represent the area.

Figure number, n	Perimeter, P (cm)	Area, A (cm^2)
1	10	4
2	16	7
3	22	10

b) As the figure number increases by 1, the perimeter increases by 6. Since $P = 10$ when $n = 1$, an equation is: $P = 4 + 6n$.

Verify the equation by substituting values from the table into the equation.

Substitute $n = 3$ and $P = 22$ in the equation:

Left side: 22   Right side: $4 + 6(3) = 4 + 18$

                                                                      $= 22$

Since the left side is equal to the right side, the equation is correct.

c) As the figure number increases by 1, the area increases by 3. An equation is: $A = 1 + 3n$

Verify the equation by substituting values from the table.

Substitute $n = 2$ and $A = 7$ in the equation:

Left side: 7   Right side: $1 + 3(2) = 1 + 6$

                                                                    $= 7$

Since the left side is equal to the right side, the equation is correct.

d) Substitute $n = 50$ in both equations.

$P = 4 + 6n$

   $= 4 + 6(50)$

   $= 4 + 300$

   $= 304$

The perimeter of figure 50 is 304 cm.

$A = 1 + 3n$

   $= 1 + 3(50)$

   $= 1 + 150$

   $= 151$

The area of figure 50 is 151 cm^2.

e) Substitute $P = 100$ in the equation $P = 4 + 6n$.

$100 = 4 + 6n$

$100 - 4 = 4 + 6n - 4$

$96 = 6n$

$\dfrac{96}{6} = \dfrac{6n}{6}$

$16 = n$

Figure 16 has perimeter 100 cm.

f) Substitute $A = 100$ in equation $A = 1 + 3n$.

$100 = 1 + 3n$

$100 - 1 = 1 + 3n - 1$

$99 = 3n$

$\dfrac{99}{3} = \dfrac{3n}{3}$

$33 = n$

Figure 33 has area 100 cm^2.

20. a) As t increases by 1, v decreases by 4. Since $v = 80$ when $t = 1$, an equation is: $v = 84 - 4t$

b) Substitute $t = 3$ and $v = 72$ in the equation.

Left side: 72   Right side: $84 - 4(3) = 84 - 12$

                                                            $= 72$

Since the left side is equal to the right side, the equation is correct.

21. a)

Number of cuts	1	2	3	4	5	6	7	8	9	10
Number of pieces	2	4	8	16	32	64	128	256	512	1024

b) As the number of cuts increases by 1, the number of pieces doubles.
The number of pieces are powers of 2.

c) To determine the number of pieces, double the number of pieces after 10 cuts 5 times:
$1024 \times 2 \times 2 \times 2 \times 2 \times 2 = 32\ 768$
There will be 32 768 pieces after 15 cuts.

d) Rewrite the number of pieces as powers of 2:

Number of cuts	1	2	3	4	5
Number of pieces	2	$(2) \times 2$ $= 2^2 = 4$	$(2 \times 2) \times 2$ $= 2^3 = 8$	$(2 \times 2 \times 2) \times 2$ $= 2^4 = 16$	$(2 \times 2 \times 2) \times 2$ $= 2^5 = 32$

Let P represent the number of pieces and let n represent the number of cuts. Since the number of pieces are powers of 2, P is related to n by the equation: $P = 2^n$

e) 15 cuts results in 32 678 pieces. I know that 16 cuts will result in double this number of pieces, or 65 356 pieces. So, 16 cuts have to be made to get more than 50 000 pieces.

Lesson 4.2   **Linear Relations**   Practice (pages 164–173)

Check

4. The graphs in parts a, b, and c represent linear relations because they are straight lines.
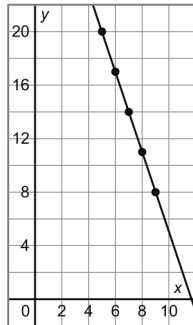
Apply

5. Determine which tables of values reflect constant change.
    a) i) Yes   **ii)** As *x* increases by 1, *y* increases by 9.
    b) i) Yes   **ii)** As *x* decreases by 1, *y* increases by 3.
    c) i) No   **iii)** As *x* increases by 1, *y* does not increase or decrease by a constant value.
    d) i) Yes   **ii)** As *x* increases by 3, *y* increases by 2.
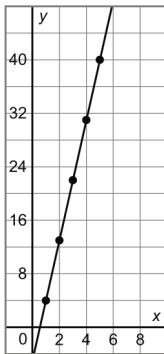
6. **a)**   **b)**

   d)
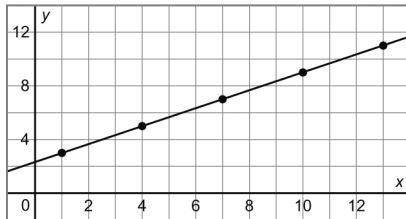
   The graph of each relation is a straight line so each is a linear relation. This verifies the results from question 5.

7. Substitute the values of *x* in each equation to find the values of *y*.

a) $y = 2x$

x	y
1	2
2	4
3	6
4	8

b) $y = x + 2$

x	y
1	3
2	4
3	5
4	6

c) $y = -2x$

x	y
2	−4
4	−8
6	−12
8	−16

d) $y = x - 2$

x	y
4	2
5	3
6	4
7	5

8. a)

x	2	3	4	5	6	7	8
y	6	9	12	15	18	21	24

As x increases by 1 from 5 to 6, y increases by 3. Since the relation is linear, it reflects constant change. So, the values for y when $x = 7$ and 8 are $18 + 3 = 21$, and $21 + 3 = 24$ respectively.

To find the values of y when $x = 2$, 3, and 4, work backward. As x decreases by 1, y decreases by 3. So, the values for y when $x = 4$, 3, and 2 are $15 - 3 = 12$, $12 - 3 = 9$, and $9 - 3 = 6$ respectively.

b) As x increases by 1, y increases by 3; y is equal to three times the value of x.

c) Since y is equal to 3 times x, an equation is: $y = 3x$. I can verify this equation by substituting values from the table. For example, when $x = 3$ then $y = 3x$

$$= 3(3)$$
$$= 9$$

This matches the value in the table, so the equation is correct.

d)
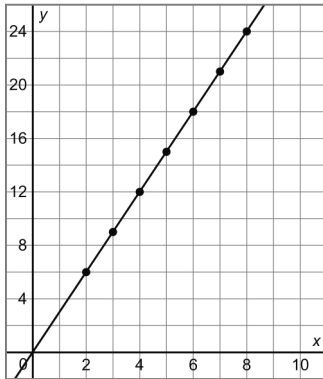
This graph shows that as x increases by 1, y increases by 3.
Each point on the graph is 1 unit right and 3 units up from the preceding point.
The points lie on a straight line so the relation is linear.

e) I could extend the table backward to the left; decreasing x by 1 and y by 3.

x	−1	0	1	2	3	4	5	6	7	8
y	−3	0	3	6	9	12	15	18	21	24

I could substitute $x = -1$ in the equation $y = 3x$ and determine the corresponding value of y.
$y = 3(-1)$
$\quad = -3$
When $x = -1$, $y = -3$

9. I know each table represents a linear relation. So, a constant change in x produces a constant change in y.

a)

x	y
2	11
3	14
4	17
5	20
6	23

As x increases by 1, y increases by 3.

b)

x	y
1	7
3	8
5	9
7	10
9	11

As x increases by 2, y increases by 1.

c)

x	y
−4	11
−2	7
0	3
2	−1
4	−5

As *x* increases by 2, *y* decreases by 4.

d)

x	y
4	−10
6	−7
8	−4
10	−1
12	2

As *x* increases by 2, *y* increases by 3.

10.

a) $y = 3x$

x	y
−2	−6
−1	−3
0	0
1	3
2	6
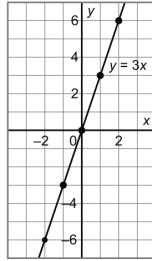
b) $y = x + 3$

x	y
−2	1
−1	2
0	3
1	4
2	5
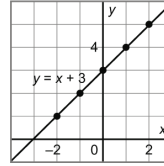
c) $y = x - 3$

x	y
−2	−5
−1	−4
0	−3
1	−2
2	−1
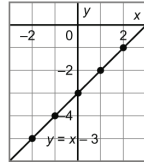
d) $y = 5 - x$

x	y
−2	7
−1	6
0	5
1	4
2	3
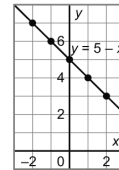
e) $y = 1 - 4x$

x	y
−2	9
−1	5
0	1
1	−3
2	−7
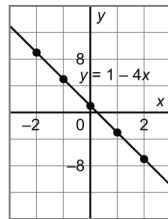
f) $y = -2x - 3$

x	y
−2	1
−1	−1
0	−3
1	−5
2	−7
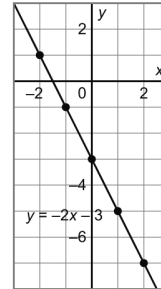
11. a) Jin travels *d* metres in 4 × (*t* seconds).
An equation is: $d = 4t$

b)

t	d
0	0
1	4
2	8
3	12
4	16
5	20

c) All the values between and beyond the plotted points are possible so I join the points with a straight line.
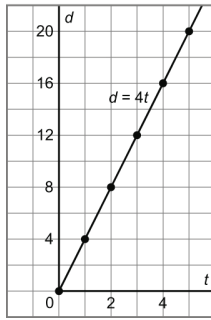
d) Yes, the relation between distance and time is linear.
   i) From the table, as t increases by 1, d increases by 4. This relationship reflects constant change.
   ii) From the graph, all the points lie on a straight line.

e) Jin travels 4 m in 1 s, so he travels 60 × 4 m in 1 min, and 60 × 60 × 4 m = 14 400 m in 1 h
   14 400 m = 14.4 km
   So, in 3.5 h, Jin travels 3.5 × 14.4 km = 50.4 km.

f) 17 km = 17 000 m
   Substitute d = 17 000 in the equation $d = 4t$, then solve for t.
   17 000 = 4t Divide both sides by 4.
   $$\frac{17\ 000}{4} = \frac{4t}{4}$$
   4250 = t
   4250 s = 4250 ÷ 60 min
          = 4250 ÷ 60 ÷ 60 h
          ≐ 1.18 h
          ≐ 1 h 11 min
   Jin takes about 1 h 11 min to travel 17 km.

12. a) The tax, T, is equal to 0.05 × (the purchase price, p). An equation is: $T = 0.05p$
   b)

p	T
0	0
10	0.50
20	1.00
30	1.50
40	2.00

c) As p increases by 10, T increases by 0.50; T is equal to 0.05 times the value of p.

d) I will plot p on the horizontal axis because T depends on the value of the purchase, so T is the dependent variable and p the independent variable.
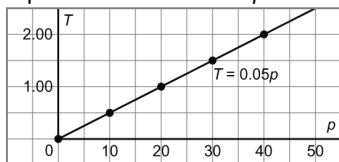
e) All the values between those in the table are permitted so I will use a straight line to join the points; all decimals will be rounded to the nearest hundredth. For example, on a purchase of $12.99, the GST is calculated as $12.99 × 0.05 = $0.6495; this is rounded to the nearest cent and I pay $0.65.

f) In the table, when p increases by 10, T increases by 0.50. On the graph, when I move 10 units right I move 0.50 units up.

13. a) Let C represent the total cost in dollars and let r represent the number of rides.
The admission fee is $10 plus $2 × (number of rides, r). An equation is: $C = 10 + 2r$, or $C = 2r + 10$

b) Create a table and graph the points.

| r	C
0	10
1	12
2	14
3	16
4	18
5	20
6	22
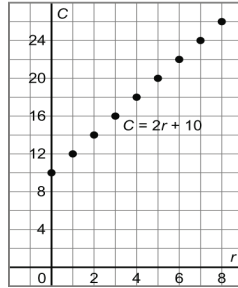
The number of rides is a whole number. We cannot go on half a ride, or any other fraction of a ride.
So, the points are not joined with a line; the data are discrete.

c) Substitute $r = 7$ into the equation $C = 2r + 10$.
$C = 2(7) + 10$
$ = 24$
7 rides cost $24.

d) Substitute $C = 38$ into the equation $C = 2r + 10$, then solve for r.
$38 = 2r + 10$ Subtract 10 from each side.
$38 - 10 = 2r + 10 - 10$
$28 = 2r$ Divide both sides by 2.
$\dfrac{28}{2} = \dfrac{2r}{2}$
$14 = r$
14 rides can be taken for $38.

14. a) In the equation $P = 3n + 6$, P represents the total number of pieces of pizza needed and n represents the number of people attending the party. Danica estimates that each person will eat 3 pieces of pizza, that is $3n$. The 6 extra pieces are represented by 6.

b)

n	P
1	9
2	12
3	15
4	18
5	21
6	24
7	27
8	30
9	33
10	36

c)
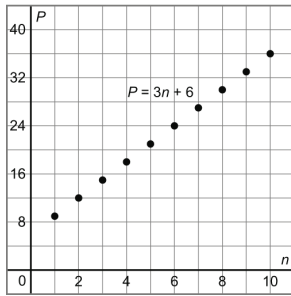
Since the number of people attending cannot include values between those given in the table, I will not join the points.

d) Yes, the relation is linear.

i) From the table of values, as n increases by 1, P increases by 3. This relationship is constant.

ii) From the graph, all the plotted points lie on a straight line.

e) Since the relation is linear, as the number of people attending increases by 1, the number of pieces of pizza needed increases by 3.

15. a) Let h represent the height in metres and t represent the time in minutes. The height decreases 150 m every minute, so, after t minutes, the height will be $1800 - 150t$. An equation is: $h = 1800 - 150t$

b) Create a table of values then plot the points on a graph.

t	h
0	1800
2	1500
4	1200
6	900
8	600
10	300
12	0
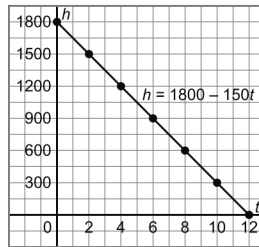
All the values between the plotted points are possible so I join the points with a straight line.

c) Substitute $t = 6$ in the equation $h = 1800 - 150t$.

$h = 1800 - 150(6)$

$\quad = 1800 - 900$

$\quad = 900$

The height of the plane 6 min after it began its descent is 900 m.

d) Substitute $h = 100$ in the equation $h = 1800 - 150t$, then solve for t.

$100 = 1800 - 150t$ Subtract 1800 from each side.

$100 - 1800 = 1800 - 150t - 1800$

$-1700 = -150t$ Divide each side by -150.

$\dfrac{-1700}{-150} = \dfrac{-150t}{-150}$
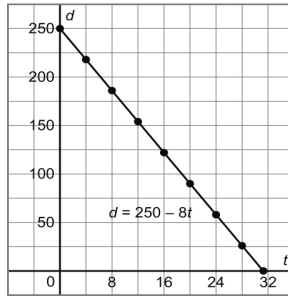
$11.\overline{3} = t$

The plane is 100 m above the ground at $11.\overline{3}$ min after starting to descend. This is, after 11 min 20 s.

16. a) Let t represent the time in hours and d represent the distance left to travel. Jada travels 8 km/h, or $8 \times t$. So, the distance after t hours is $250 - 8t$; an equation is: $d = 250 - 8t$

b) Create a table of values then plot the points on a graph.

t	d
0	250
4	218
8	186
12	154
16	122
20	90
24	58
28	26
32	0

All the values between the plotted points are possible so I join the points with a straight line.

c) Substitute $t = 12$ in the equation $d = 250 - 8t$.

$d = 250 - 8(12)$
$ = 250 - 96$
$ = 154$

Jada has 154 km to travel after 12 h.

d) Jada will have completed her trip when the distance she has yet to travel is 0 km. Substitute $d = 0$ in the equation $d = 250 - 8t$, then solve for t.

$0 = 250 - 8t$ Subtract 250 from each side.
$0 - 250 = 250 - 8t - 250$
$-250 = -8t$ Divide each side by -8.
$\dfrac{-250}{-8} = \dfrac{-8t}{-8}$

$31.25 = t$

It will take Jada 31.25 h, or 31 h 15 min to complete the trip.

17. Answers may vary.

a) Devon currently has 5 movies in his DVD collection. Each week he buys two more movies.
The total number of movies, M, in his collection after n weeks is given by $M = 2n + 5$.

b) Taya charges $3.50 per hour to provide childcare.
The total amount earned, E dollars, for n hours is given by the equation $E = 3.5n$.

c) The charge for renting a stretch limousine is $12 plus $5 for each kilometre travelled.
The total cost, C dollars, for travelling d kilometres is given by $C = 12 + 5d$.

d) An amount of $5 a week is removed from a savings account with $100 in it.
The amount, H dollars, that remains after n weeks is given by the equation $H = 100 - 5n$.

Take It Further

18.

x	−3	−1	2	5	9	14	20
y	29	26.6	23	19.4	14.6	8.6	1.4

From the table, when x increases by 5, y decreases by 6. This means that when x increases by $\dfrac{5}{5} = 1$,

y will decrease by $\dfrac{6}{5}$, or 1.2. When $x = -1$, x has increased by 2, so y will decrease by $2 \times 1.2 = 2.4$.

Therefore, $y = 29 - 2.4 = 26.6$. I used a similar approach to determine the remaining values.

Lesson 4.3   **Another Form of the Equation for a Linear Relation**   **Practice (pages 174–180)**

Check

4. a) The graph is a vertical line; every point on the graph has an *x*-coordinate of –2.
So, the equation is i: $x = -2$

  b) The graph is a horizontal line; every point on the graph has a *y*-coordinate of –2.
So, the equation is iii: $y = -2$

5. a) The graph is a horizontal line that intersects the *y*-axis at 7.

  b) The graph is an oblique line.

  c) The graph is a vertical line that intersects the *x*-axis at –5.

  d) Solve for *x*: $x + 9 = 0$
$$x + 9 - 9 = 0 - 9 \quad \text{Subtract 9 from each side.}$$
$$x = -9$$
The graph is a vertical line that intersects the *x*-axis at –9.

  e) Solve for *y*: $2y = 5$
$$\frac{2y}{2} = \frac{5}{2} \qquad \text{Divide both sides by 2.}$$
$$y = \frac{5}{2} \text{ , or 2.5}$$
The graph is a horizontal line that intersects the *y*-axis at 2.5.
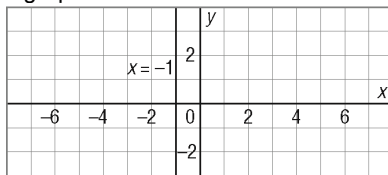
  f) The graph is an oblique line.

Apply

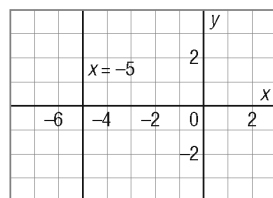**6. a)** The graph is a horizontal line that intersects the *y*-axis at 5.
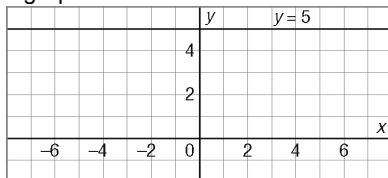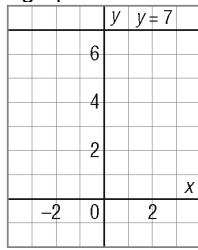

  b) The graph is a vertical line that intersects the *x*-axis at –1.

  c) The graph is a vertical line that intersects the *x*-axis at –5.

d) The graph is a horizontal line that intersects the *y*-axis at 7.

7. a) All the points have *y*-coordinate 2; the equation is $y = 2$.

b) All the points have *x*-coordinate 1; the equation is $x = 1$.

c) All the points have *x*-coordinate –5; the equation is $x = -5$.

8. The graph is that of $x = -\dfrac{1}{2}$. Solve each equation and compare the results to $x = -\dfrac{1}{2}$.

a) $x - 2 = 0$ Add 2 to each side.
$x - 2 + 2 = 0 + 2$
$x = 2$

b) $2x + 1 = 0$ Subtract 1 from each side.
$2x + 1 - 1 = 0 - 1$
$2x = -1$ Divide both sides by 2.
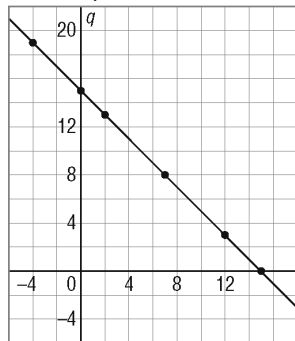$\dfrac{2x}{2} = -\dfrac{1}{2}$
$x = -\dfrac{1}{2}$

c) Since *x* does not appear in this equation, the equation cannot describe the graph.

d) $2x - 1 = 0$ Add 1 to each side.
$2x - 1 + 1 = 0 + 1$
$2x = 1$ Divide both sides by 2.
$\dfrac{2x}{2} = \dfrac{1}{2}$
$x = \dfrac{1}{2}$

Comparing results, we see that part b is a match for the graph: $2x + 1 = 0$.

9. a) Tables may vary. For example,

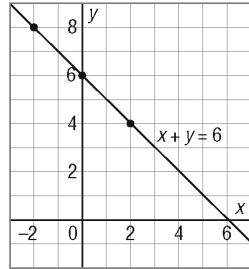| p	q
–4	19
0	15
2	13
7	8
12	3
15	0

b) Yes, since p and q can be fractions, the points should be joined with a line.

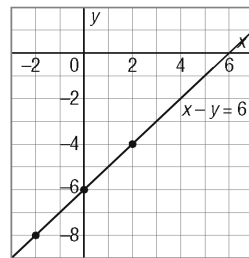**c)** Since the two numbers add up to 15, an equation is: $p + q = 15$
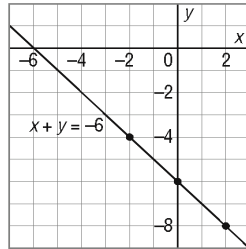
10. a)

i) $x + y = 6$

x	y
−2	8
0	6
2	4

ii) $x − y = 6$

x	y
−2	−8
0	−6
2	−4

iii) $x + y = −6$

x	y
−2	−4
0	−6
2	−8

iv) $x − y = −6$

x	y
−2	4
0	6
2	8
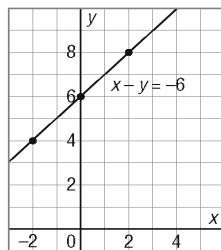
b) All the graphs are straight lines, so they represent linear relations.
For the graphs in parts i and iii, as x increases by 1, y decreases by 1.
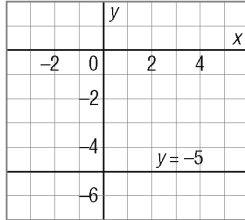For the graphs in parts ii and iv, as x increases by 1, y increases by 1.
The graphs in parts i and iv intersect the y-axis at 6.
The graphs in parts ii and iii intersect the y-axis at −6.
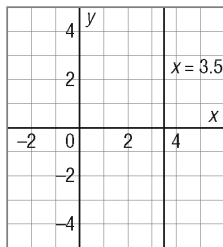
11. Since all the equations involve only one variable, I will solve for that variable before I graph.

a) $y + 3 = -2$ Subtract 3 from each side.
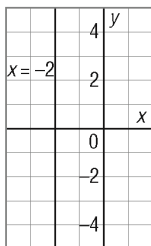$y + 3 - 3 = -2 - 3$
$y = -5$

The y-coordinate of every point on this line is –5.
The graph is a horizontal line that intersects the y-axis at –5.

b) $2x = 7$ Divide each side by 2.
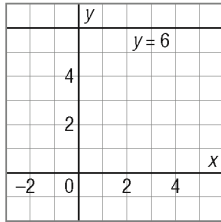$$\frac{2x}{2} = \frac{7}{2}$$
$x = 3.5$

The x-coordinate of every point on this line is 3.5.
The graph is a vertical line that intersects the x-axis at 3.5.

c) $3x + 1 = -5$ Subtract 1 from each side.
$3x + 1 - 1 = -5 - 1$
$3x = -6$ Divide both sides by 3.
$$\frac{3x}{3} = \frac{-6}{3}$$
$x = -2$

The x-coordinate of every point on this line is –2.
The graph is a vertical line that intersects the x-axis at –2.

d) $2y - 2 = 10$ Add 2 to each side.

$2y - 2 + 2 = 10 + 2$

$\dfrac{2y}{2} = \dfrac{12}{2}$ Divide both sides by 2.

$y = 6$

The y-coordinate of every point on this line is 6.
The graph is a horizontal line that intersects the *y*-axis at 6.

12. The vertical line at the left side of the rectangle intersects the *x*-axis at –1, so its equation is $x = -1$.
The vertical line at the right side of the rectangle intersects the *x*-axis at 4, so its equation is $x = 4$.
The horizontal line at the top of the rectangle intersects the *y*-axis at 3, so its equation is $y = 3$.
The horizontal line at the bottom of the rectangle intersects the *y*-axis at –4, so its equation is $y = -4$.
So, the rectangle is bordered by lines with equations: $x = -1$
$$x = 4$$
$$y = 3$$
$$y = -4$$

13. a) Solve for the variables in parts iii and iv before graphing.

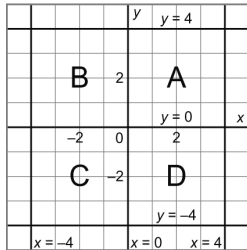   **iii)** $x - 1 = 0$ Add 1 to each side.

    $x - 1 + 1 = 0 + 1$

    $x = 1$

    iv) $y + 2 = 0$ Subtract 2 from each side.

    $y + 2 - 2 = 0 - 2$

    $y = -2$
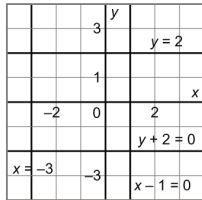
A square is formed with side length 4 units.

b), d) Any square of side length 4, with one vertex at the origin, will be congruent.
Each of A, B, C, and D is a possible answer.

c) For shape A, the equations for the two vertical lines are $x = 0$ and $x = 4$ and the equations for the two horizontal lines are $y = 0$ and $y = 4$.

d) The graph shows 3 more possible shapes.

For shape B, the equations for the two vertical lines are $x = -4$ and $x = 0$ and the equations for the two horizontal lines are $y = 4$ and $y = 0$.
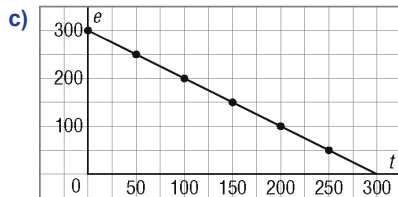
For shape C, the equations for the two vertical lines are $x = -4$ and $x = 0$ and the equations for the two horizontal lines are $y = 0$ and $y = -4$.

For shape D, the equations for the two vertical lines are $x = 0$ and $x = 4$ and the equations for the two horizontal lines are $y = 0$ and $y = -4$.

14.a)

Distance travelled, *t* (km)	Distance to Edmonton, *e* (km)
0	300
50	250
100	200
150	150
200	100
300	0

b) The greatest value of *t* is 300. When the distance travelled is 300 km, then Kate is in Edmonton.
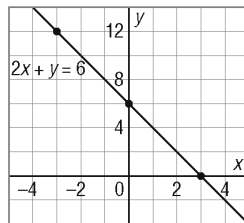
c)

Since the distances can be values between those shown in the table, the points should be joined.

d) Since the distance between Edmonton and Calgary is 300 km, *t* and *e* have a sum of 300.
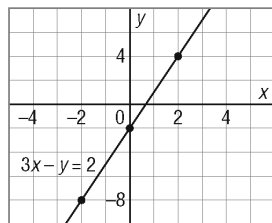An equation is: $t + e = 300$

15.

a) $2x + y = 6$

x	y
−3	12
0	6
3	0

b) $3x - y = 2$

x	y
−2	−8
0	−2
2	4

c) $x + 2y = -6$

x	y
-4	-1
0	-3
4	-5
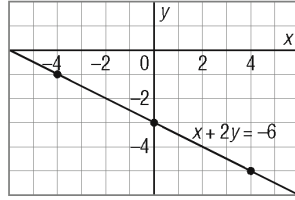
d) $3x - 2y = -6$

x	y
-2	0
0	3
2	6
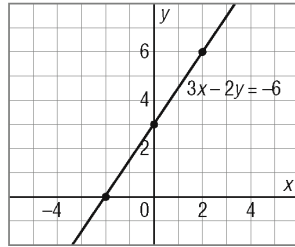
16. a)
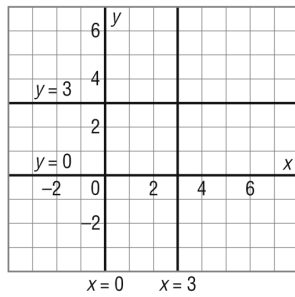
b) The equations for the two vertical lines are $x = 0$ and $x = 3$.
The equations for the two horizontal lines are $y = 3$ and $y = 0$.

c) Here are 3 more squares that can be drawn with one vertex at (0, 0), and horizontal and vertical sides.

For one square, the equations are $x = -3$, $x = 0$, $y = -3$, and $y = 0$.

For a second square, the equations are $x = -3$, $x = 0$, $y = 0$, and $y = 3$.

For a third square, the equations are $x = 0$, $x = 3$, $y = -3$, and $y = 0$.
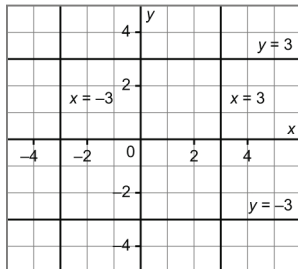
17. a)

a	b
−2	−8
0	−6
2	−4
4	−2
6	0
8	2

c)

b) Since the numbers a and b could include values between the plotted points, the points should be joined.

c) Since the 2 numbers have a difference of 6 and the greater number is a, an equation is: $a - b = 6$

18. a) $x = 2$ is a vertical line intersecting the x-axis at 2; $y = 1$ is a horizontal line intersecting the y-axis at 1.
Make a table for $x + y = 8$:

$x + y = 8$

x	y
8	0
5	3
0	8

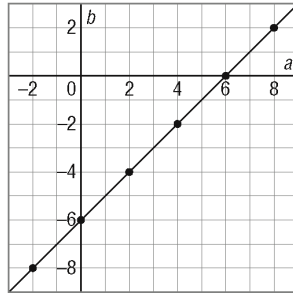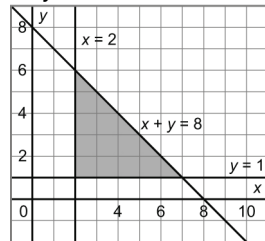**b)** The lines form a right triangle. I know the angle at (2, 1) is a right angle because the horizontal line $y = 1$ and the vertical line $x = 2$ are perpendicular. The line $x + y = 8$ is oblique and is the hypotenuse of the right triangle.

Take It Further

19. a) Let x represent one number and y the second number.

x	y
$3\frac{1}{2}$	−1
$2\frac{1}{2}$	0
$1\frac{1}{2}$	1
0	$2\frac{1}{2}$
−1	$3\frac{1}{2}$
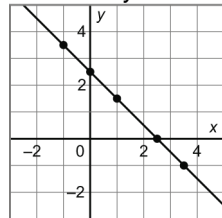
b) The graph is an oblique line that intersects both axes at $2\frac{1}{2}$.

c) Since the two numbers have a sum of $2\frac{1}{2}$, an equation is: $x + y = 2\frac{1}{2}$

20. a) Let s and u represent the two rational numbers and let u be the greater number.

s	u
7	14.5
3.5	11
0	7.5
−3.5	4
−7.5	0

b)
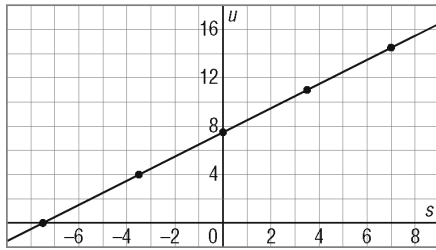
The graph is an oblique line that intersects the *s*-axis at –7.5 and the *u*-axis at 7.5.

c) Since the two numbers have a difference of –7.5 and *u* is the greater number, an equation is:
$s - u = -7.5$

21. a) $\frac{1}{2}x + y = 4$

x	y
–4	6
0	4
8	0
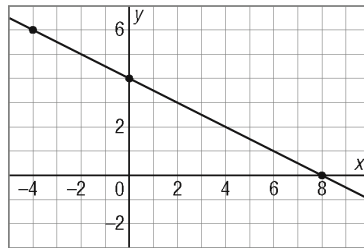
b) $\frac{1}{3}x - y = 2$

x	y
–3	–3
0	–2
3	–1
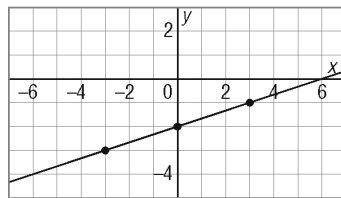
c) $\frac{1}{2}x + \frac{1}{3}y = 6$

x	y
0	18
4	12
12	0
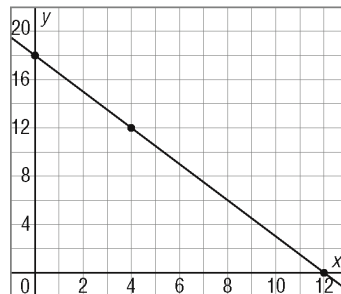
d) $\dfrac{1}{3}x - \dfrac{1}{2}y = -1$

x	y
−3	0
0	2
3	4
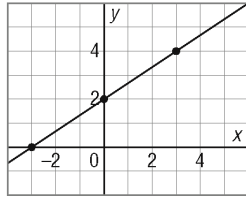
e) $\dfrac{1}{3}x + \dfrac{1}{2}y = -3$

x	y
−9	0
−3	−4
0	−6
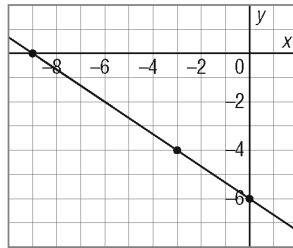
f) $\dfrac{1}{4}x - \dfrac{1}{2}y = 1$

x	y
−4	−4
2	−1
6	1
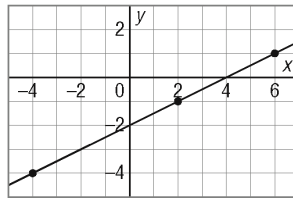
Lesson 4.1

1. a)

Figure Number, n	Perimeter, P
1	$4 = 6(1) - 2$
2	$10 = 6(2) - 2$
3	$16 = 6(3) - 2$
4	$22 = 6(4) - 2$

As n increases by 1, P increases by 6.
The perimeter is equal to 6 times the figure number, minus 2.

b) An expression for the perimeter of figure n is: $6n - 2$

c) Substitute $n = 40$ in the expression $6n - 2$.
$6(40) - 2 = 240 - 2$
$\qquad\qquad = 238$
The perimeter of figure 40 is 238 units.

d) An equation is: $P = 6n - 2$

e) Substitute $P = 136$ in the equation $P = 6n - 2$.
$136 = 6n - 2$ Add 2 to each side.
$136 + 2 = 6n - 2 + 2$
$138 = 6n$ Divide both sides by 6.
$\dfrac{138}{6} = \dfrac{6n}{6}$
$23 = n$
Figure 23 has a perimeter of 136 units.

2. a) The cost is $10 plus $0.25 × (each minute).
So, an equation is: $C = 10 + 0.25t$

b) Substitute $t = 55$ in the equation $C = 10 + 0.25t$.
$C = 10 + 0.25(55)$
$\quad = 10 + 13.75$
$\quad = 23.75$
The monthly cost was $23.75.

c) Substitute $C = 22.50$ in the equation $C = 10 + 0.25t$.
$22.50 = 10 + 0.25t$ Subtract 10 from each side.
$22.50 - 10 = 10 + 0.25t - 10$
$12.50 = 0.25t$ Divide both sides by 0.25.
$\dfrac{12.50}{0.25} = \dfrac{0.25t}{0.25}$
$50 = t$
50 minutes of long distance calls were made.

Lesson 4.2

3.

a)

$y = -3x$	
x	**y**
−3	9
−1	3
1	−3
3	−9
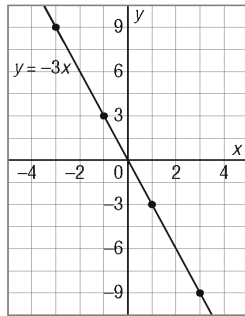
b)

$y = 2x$	
x	**y**
−3	−6
−1	−2
1	2
3	6
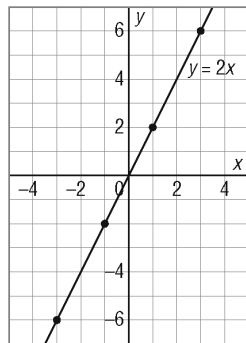
c)

$y = 2 - 4x$	
x	**y**
−3	14
−1	6
1	−2
3	−10

d)

$y = -2x + 4$	
x	**y**
−3	10
−1	6
1	2
3	−2

e)

$y = -3 + x$	
x	**y**
−3	−6
−1	−4
1	−2
3	0

f)

$y = -x + 3$	
x	**y**
−3	6
−1	4
1	2
3	0
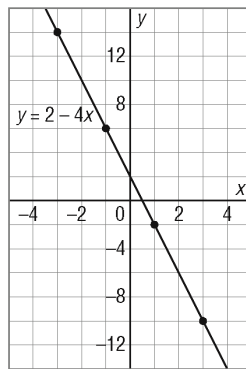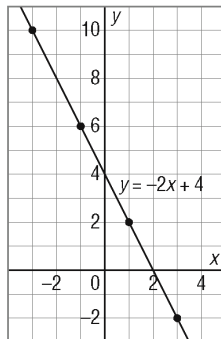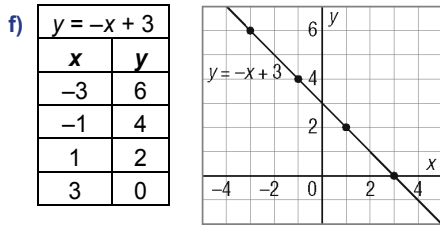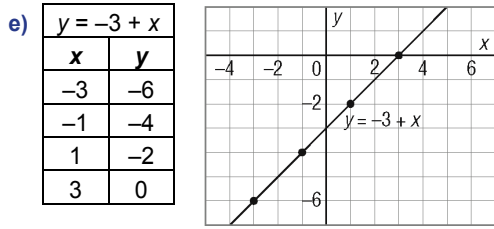
4. a)

Week, n	Total Paid, P ($)
1	45
2	60
3	75
4	90
5	105

b)
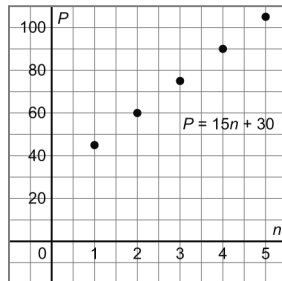
Since the payments are made each week, the plotted points should not be joined; the data are discrete.

c) In the table, when *n* increases by 1, *P* increases by 15.
On the graph, when we move right 1 unit, we move 15 units up.

5. Since the relations are linear, corresponding changes in each table are constant.
To complete each table, continue the pattern:
a) As *x* increases by 1, *y* increases by 4.

x	y
1	10
2	14
3	18
4	22
5	26

b) As *x* increases by 2, *y* decreases by 4.

x	y
1	–6
3	–10
5	–14
7	–18
9	–22

c) As *x* increases by 1, *y* increases by 6.

x	y
–2	–15
–1	–9
0	–3
1	3
2	9

d) As *x* increases by 2, *y* decreases by 3.

x	y
2	1
4	–2
6	–5
8	–8
10	–11

Lesson 4.3

6. a) i) *y* = 1
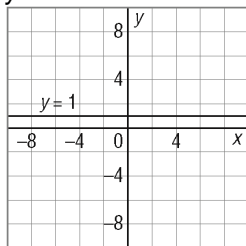
ii) *x* = –4
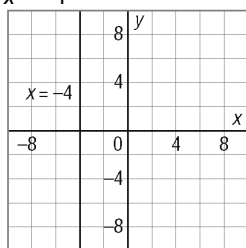
iii) $x + y = 8$

x	y
0	8
3	5
8	0
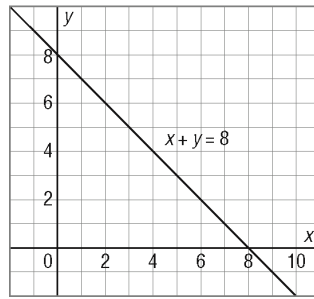
iv) $2x - y = 12$

x	y
3	-6
5	-2
7	2
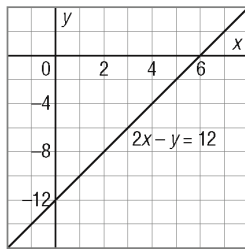
b) I did not need to make a table of values for equations i and ii.
The graph of $y = 1$ is a horizontal line that intersects the y-axis at 1.
The graph of $x = -4$ is a vertical line that intersects the x-axis at -4.

7. a) Tables may vary.

g	n
5	4
2	1
-1	-2
-4	-5
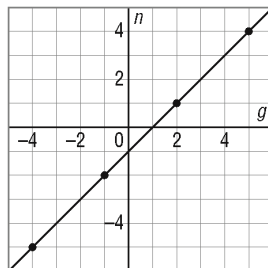
b) Since the numbers g and n could include values between the plotted points, the points should be joined.

c) Since the two numbers have a difference of 1 and g is the greater number, an equation is: $g - n = 1$

Lesson 4.4   **Matching Equations and Graphs**   Practice (pages 183–190)

Check

3. a) $y = 2x$; from this equation, the 2 indicates that when x increases by 1, y increases by 2.
This matches Graph iii: when we move 1 unit right, we move 2 units up.

b) $y = 4x$; from this equation, the 4 indicates that when x increases by 1, y increases by 4.
This matches Graph i: when we move 1 unit right, we move 4 units up.

c) $y = -x$; from this equation, the –1 indicates that when x increases by 1, y decreases by 1.
This matches Graph ii: when we move 1 unit right, we move 1 unit down.

Apply

4. a) $y = 3x$; from this equation, the 3 indicates that when x increases by 1, y increases by 3.
This matches Graph C: when we move 1 unit right, we move 3 units up.

b) $y = 5x$; from this equation, the 5 indicates that when x increases by 1, y increases by 5.
This matches Graph B: when we move 1 unit right, we move 5 units up.

c) $y = -2x$; from this equation, the –2 indicates that when x increases by 1, y decreases by 2.
This matches Graph A: when we move 1 unit right, we move 2 units down.

5. Make a table of values for each equation, then identify the graph on which the 3 points lie.

a) $y = 2x + 1$

x	y
0	1
1	3
2	5

Graph ii passes through these 3 points.

b) $y = 2x + 3$

x	y
0	3
1	5
2	7

Graph iii passes through these 3 points.

c) $y = 2x - 5$

x	y
0	–5
1	–3
2	–1

Graph i passes through these 3 points.

6. Make a table of values for each equation, then identify the graph on which the 3 points lie.

a) $x + y = 4$

x	y
0	4
1	3
2	2

Graph i passes through these 3 points.

b) $x - y = 4$

x	y
0	–4
1	–3
2	–2

Graph iii passes through these 3 points.

c) $x - y = -4$

x	y
0	4
1	5
2	6

Graph ii passes through these 3 points.

7. **a)** The relation described by the equation $y = 2x$ is an oblique line.
  The only graph that is an oblique line is Graph B.

  b) The relation described by the equation $2y = 7$ is a horizontal line.
  Solve for y to get:
  $2y = 7$ Divide both sides by 2.
  $\dfrac{2y}{2} = \dfrac{7}{2}$

  $y = \dfrac{7}{2}$

  This is a horizontal line that intersects the y-axis at $\dfrac{7}{2}$, which matches Graph A.

  c) The relation described by the equation $3y = 2$ is a horizontal line.
  Solve for y to get:
  $3y = 2$ Divide both sides by 3.
  $\dfrac{3y}{2} = \dfrac{2}{3}$

  $y = \dfrac{2}{3}$

  This is a horizontal line that passes through the y-axis at $\dfrac{2}{3}$, which matches Graph C.

8. Choose 2 points on each graph and check to see if their coordinates satisfy the equation.

  Two points on Graph A are: (1, 2) and (2, –1)
  Substitute $x = 1$ and $y = 2$ in $y = 2x + 5$.
  Left side: $y = 2$ Right side: $2x + 5 = 2(1) + 5$
                                    $= 7$
  The left side does not equal the right side, so this point is not on the line.

  Two points on Graph B are: (–2, 1) and (1, 7)
  Substitute $x = -2$ and $y = 1$ in $y = 2x + 5$.
  Left side: $y = 1$ Right side: $2x + 5 = 2(-2) + 5$
                                    $= 1$
  The left side is equal to the right side, so this point lies on the line.

Substitute $x = 1$ and $y = 7$ in $y = 2x + 5$.
Left side: $y = 7$ Right side: $2x + 5 = 2(1) + 5$
                                                                        $= 7$
The left side is equal to the right side, so this point lies on the line.
Since both points satisfy the equation, Graph B has equation $y = 2x + 5$.

9. Choose 2 points on each graph, then substitute the coordinates into each equation in turn, to determine which equation is satisfied by both points.

   a) Two points on the graph have coordinates (0, 2) and (2, 0).
      i) Substitute $x = 0$ and $y = 2$ in $y = 2x + 1$.
         Left side: $y = 2$ Right side: $2x + 1 = 2(0) + 1$
                                                                        $= 1$
         Since the left side is not equal to the right side, the equation does not describe the graph.

      ii) Substitute $x = 0$ and $y = 2$ in $y = 2x + 3$.
         Left side: $y = 2$ Right side: $2x + 3 = 2(0) + 3$
                                                                        $= 3$
         Since the left side is not equal to the right side, the equation does not describe the graph.

      iii) Substitute $x = 0$ and $y = 2$ in $y = x - 2$.
         Left side: $y = 2$ Right side: $x - 2 = 0 - 2$
                                                                        $= -2$
         Since the left side is not equal to the right side, the equation does not describe the graph.

      iv) Substitute $x = 0$ and $y = 2$ in $y = -x + 2$.
         Left side: $y = 2$ Right side: $-x + 2 = -0 + 2$
                                                                        $= 2$
         Since the left side is equal to the right side, the point satisfies the equation $y = -x + 2$.

         Substitute $x = 2$ and $y = 0$ in $y = -x + 2$.
         Left side: $y = 0$ Right side: $-x + 2 = -2 + 2$
                                                                        $= 0$
         Since the left side is equal to the right side, the point satisfies the equation $y = -x + 2$.
         Since both points on the graph satisfy the equation, $y = -x + 2$ describes the graph.

   b) Two points on the graph have coordinates (−1, 0) and (0, 3).
      i) Substitute $x = -1$ and $y = 0$ in $x + 3y = 1$.
         Left side: $x + 3y = -1 + 3(0)$ Right side: 1
                              $= -1$
         Since the left side is not equal to the right side, the equation does not describe the graph.

      ii) Substitute $x = -1$ and $y = 0$ in $3x - y = -3$.
         Left side: $3x - y = 3(-1) - 0$ Right side: -3
                              $= -3$
         Since the left side is equal to the right side, the point satisfies the equation $3x - y = -3$.

         Substitute $x = 0$ and $y = 3$ in $3x - y = -3$.
         Left side: $3x - y = 3(0) - 3$ Right side: -3
                              $= -3$
         Since the left side is equal to the right side, the point satisfies the equation $3x - y = -3$.
         Since both points on the graph satisfy the equation, $3x - y = -3$ describes the graph.

10 Answers may vary.

a) My equations are $y = 3x + 1$, $y = 5$, and $x + y = 3$

b)
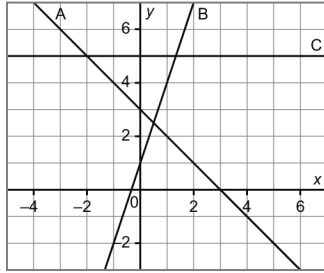
11. a) These 4 graphs are alike in that for each table of values, as x increases by 1, y increases by 2.
They are all straight lines so all represent linear relations.

b) The four graphs are different in that all of them pass through different points on the x-axis and the y-axis.

c) Make a table of values for each equation, then identify on which graph each set of points lies.

i) $y = 2x - 2$

x	y
0	−2
1	0
2	2

i) Graph C passes through these 3 points.

ii) $y = 2x + 4$

x	y
0	4
1	6
2	8

Graph A passes through these 3 points.

iii) $2x - y = 6$

x	y
0	−6
1	−4
2	−2

Graph D passes through these 3 points.

iv) $2x - y = -1$

x	y
0	1
1	3
2	5

Graph B passes through these 3 points.

d) Yes, I found the coordinates of 3 points that satisfy each equation, then determined on which graph the 3 points lie. I used this method because I find it the easiest.

12. a) Point P lies on the two oblique lines.
Point Q has coordinates (–4, 1).
Substitute these coordinates into the equation of each oblique line.

Substitute $x = -4$ and $y = 1$ in $2x + y = 8$.
Left side: $2x + y = 2(-4) + 1$ Right side: 8
$\qquad\qquad = -8 + 1$
$\qquad\qquad = -7$
The left side does not equal the right side so Q does not lie on $2x + y = 8$.

Substitute $x = -4$ and $y = 1$ in $2y - x = 6$.
Left side: $2y - x = 2(1) - (-4)$ Right side: 6
$\qquad\qquad = 6$
The left side is equal to the right side, so Q lies on $2y - x = 6$. Since P also lies on this line, PQ lies on the line with equation $2y - x = 6$.

b) Points Q and R lie on the horizontal line that intersects the y-axis at $y = 1$. So, QR lies on the line with equation $y = 1$.

c) Point R has coordinates (3.5, 1).
Check that this point lies on the line with equation $2x + y = 8$.

Substitute $x = 3.5$ and $y = 1$ in $2x + y = 8$.
Left side: $2x + y = 2(3.5) + 1$ Right side: 8
$\qquad\qquad = 7 + 1$
$\qquad\qquad = 8$
The left side is equal to the right side, so R lies on $2x + y = 8$. Substitute $x = -4$ and $y = 1$ in $2y - x = 6$.
Left side: $2y - x = 2(1) - (-4)$ Right side: 6
$\qquad\qquad = 6$
The left side is equal to the right side, so R lies on $2x + y = 8$. So, RP lies on the line with equation $2x + y = 8$.

Take It Further

13. a) Two points on DE have coordinates (–4, 2) and (0, 4). Substitute these coordinates in each equation.
For $y = -2x + 5$:
Substitute $x = -4$ and $y = 2$.
Left side: $y = 2$ Right side: $-2x + 5 = -2(-4) + 5$
$\qquad\qquad\qquad\qquad\qquad\qquad = 8 + 5$
$\qquad\qquad\qquad\qquad\qquad\qquad = 13$
Since the left side is not equal to the right side, DE does not have equation $y = -2x + 5$.

For $y = -2x - 8$:
Substitute $x = 0$ and $y = 4$.
Left side: $y = 4$ Right side: $-2x - 8 = -2(0) - 8$
$\qquad\qquad\qquad\qquad\qquad\qquad = -8$
Since the left side is not equal to the right side, DE does not have equation $y = -2x - 8$.

For $x - 2y = -8$:
Substitute $x = 0$ and $y = 4$.
Left side: $x - 2y = 0 - 2(4)$ Right side: -8
$\qquad\qquad = -8$
Since the left side is equal to the right side, the point (0, 4) lies on the line.

Substitute $x = -4$ and $y = 2$.
Left side: $x - 2y = -6 - 2(-2)$ Right side: -8
                    $= -8$
Since the left side is equal to the right side, the point $(-6, 1)$ lies on the line.
So, DE lies on the line with equation $x - 2y = -8$.

b) Two points on DG have coordinates $(-4, 0)$ and $(-3, -2)$.
Substitute these coordinates in each equation.
For $y = -2x + 5$:
Substitute $x = -4$ and $y = 0$.
Left side: $y = 0$ Right side: $-2x + 5 = -2(-4) + 5$
                                                                $= 13$
Since the left side is not equal to the right side, DG does not have equation $y = -2x + 5$.

For $y = -2x - 8$:
Substitute $x = -4$ and $y = 0$.
Left side: $y = 0$ Right side: $-2x - 8 = -2(-4) - 8$
                                                                $= 0$
Since the left side is equal to the right side, the point $(-4, 0)$ lies on the line.

Substitute $x = -3$ and $y = -2$.
Left side: $y = -2$ Right side: $-2x - 8 = -2(-3) - 8$
                                                                $= -2$
Since the left side is equal to the right side, the point $(-3, -2)$ lies on the line.
So, DG lies on the line with equation $y = -2x - 8$.

c) Two points on EF have coordinates $(1, 3)$ and $(2, 1)$.
Substitute these coordinates in each equation.
For $y = -2x + 5$:
Substitute $x = 1$ and $y = 3$.
Left side: $y = 3$ Right side: $-2x + 5 = -2(1) + 5$
                                                                $= -2 + 5$
                                                                $= 3$
Since the left side is equal to the right side, the point $(1, 3)$ lies on the line.

Substitute $x = 2$ and $y = 1$.
Left side: $y = 1$ Right side: $-2x + 5 = -2(2) + 5$
                                                                $= -4 + 5$
                                                                $= 1$
Since the left side is equal to the right side, the point $(2, 1)$ lies on the line.
So, EF lies on the line with equation $y = -2x + 5$.

d) Two points on FG have coordinates $(-1, -1)$ and $(-3, -2)$. Substitute these coordinates in each
equation.
For $y = \dfrac{1}{2}x - \dfrac{1}{2}$:
Substitute $x = -1$ and $y = -1$.
Left side: $y = -1$ Right side: $\dfrac{1}{2}x - \dfrac{1}{2} = \dfrac{1}{2}(-1) - \dfrac{1}{2}$
                                                                $= -\dfrac{1}{2} - \dfrac{1}{2}$
                                                                $= -1$
Since the left side is equal to the right side, the point $(-1, -1)$ lies on the line.

Substitute $x = -3$ and $y = -2$.

Left side: $y = -2$ Right side: $\dfrac{1}{2}x - \dfrac{1}{2} = \dfrac{1}{2}(-3) - \dfrac{1}{2}$

$$= -\dfrac{3}{2} - \dfrac{1}{2}$$

$$= -\dfrac{4}{2}$$

$$= -2$$

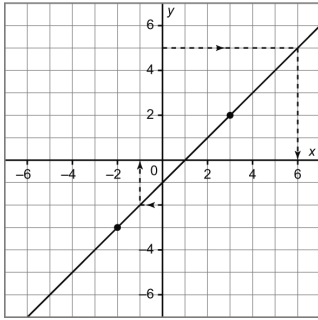Since the left side is equal to the right side, the point $(-3, -2)$ lies on the line.

So, FG lies on the line with equation $y = \dfrac{1}{2}x - \dfrac{1}{2}$.

Check

4. a)

   i) Begin at 5 on the y-axis. Move horizontally to the graph and then vertically to the x-axis.
       When $y = 5$, $x = 6$
   ii) The graph intersects the y-axis at –1, so when $y = -1$, $x = 0$
   iii) Begin at –2 on the y-axis. Move horizontally to the graph and then vertically to the x-axis.
       When $y = -2$, $x = -1$

b)
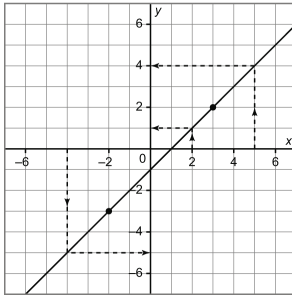
   i) Begin at –4 on the x-axis. Move vertically to the graph and then horizontally to the y-axis.
       When $x = -4$, $y = -5$
   ii) Begin at 2 on the x-axis. Move vertically to the graph and then horizontally to the y-axis.
       When $x = 2$, $y = 1$
   iii) Begin at 5 on the x-axis. Move vertically to the graph and then horizontally to the y-axis.
       When $x = 5$, $y = 4$

5. a)
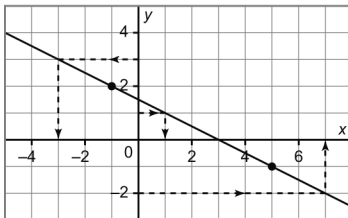
   i) Begin at 3 on the y-axis. Move horizontally to the graph and then vertically to the x-axis.
       When $y = 3$, $x = -3$
   ii) Begin at 1 on the y-axis. Move horizontally to the graph and then vertically to the x-axis.
       When $y = 1$, $x = 1$
   iii) Begin at –2 on the y-axis. Move horizontally to the graph and then vertically to the x-axis.
       When $y = -2$, $x = 7$

b)

   i) Begin at –3 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
      When *x* = –3, *y* = 3
   ii) The graph intersects the *x*-axis at 3, so when *x* = 3, *y* = 0
   iii) Begin at 6 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
      When $x = 6$, $y = -\dfrac{3}{2}$, or $-1\dfrac{1}{2}$

6. Extend the graph to include *y* values from –8 to 6 and *x* values from –6 to 9.
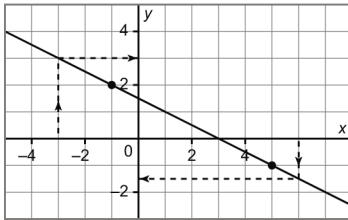
  a)
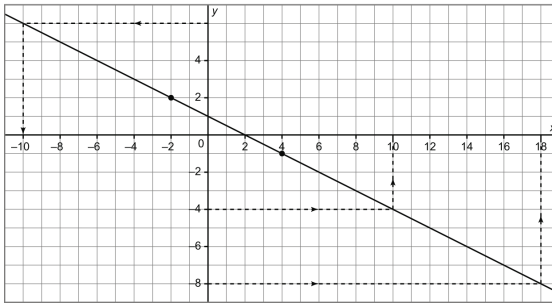
   i) Begin at 6 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
      When *y* = 6, *x* = –10
   ii) Begin at –4 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
      When *y* = –4, *x* = 10
   iii) Begin at –8 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
      When *y* = –8, *x* = 18

  b)

   i) Begin at –6 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
      When *x* = –6, *y* = 4
   ii) Begin at 6 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
      When *x* = 6, *y* = –2
   iii) Begin at 9 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
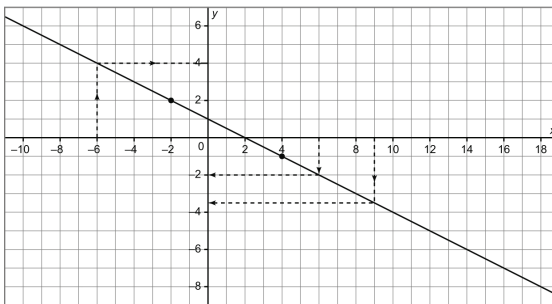   When $x = 5$, $y = -\dfrac{7}{2}$, or $-3\dfrac{1}{2}$

7. Extend this graph to include *y* values from –7 to 6 and *x* values from –5 to 5.

a)

i) Begin at 6 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.

When $y = 6$, $x = \dfrac{5}{2}$, or 2.5

ii) Begin at –4 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.

When $y = -4$, $x = -\dfrac{5}{2}$, or –2.5

iii) Begin at –7 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
When $y = -7$, $x = -4$

b)
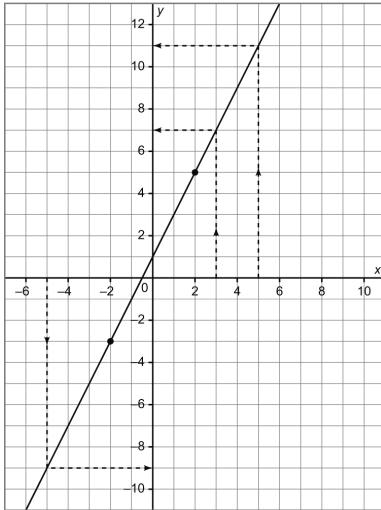
i) Begin at –5 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
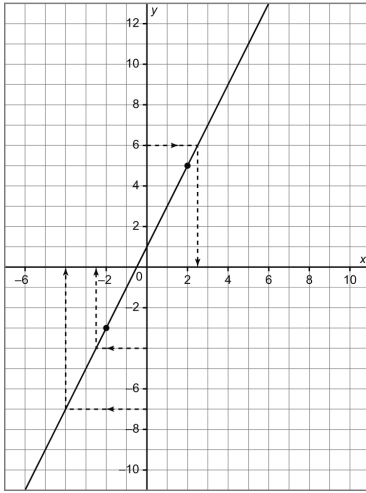When $x = -5$, $y = -9$
ii) Begin at 3 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
When $x = 3$, $y = 7$
iii) Begin at 5 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
When $x = 5$, $y = 11$

Apply

8.

Cost of a Game Console
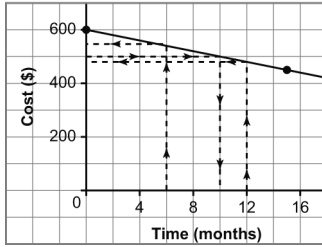
a) Begin at 5 on the *Time* axis. Move vertically to the graph and then horizontally to the *Cost* axis.
   Five months after it is released, the game console will cost about $550.

b) Begin at 500 on the *Cost* axis. Move horizontally to the graph and then vertically to the *Time* axis.
   After about 10 months, the console will cost $500.

c) Begin at 12 on the *Time* axis. Move vertically to the graph and then horizontally to the *Cost* axis.
   One year after it is released, the game console will cost about $480.

9.

Energy Burned on an Elliptical Machine
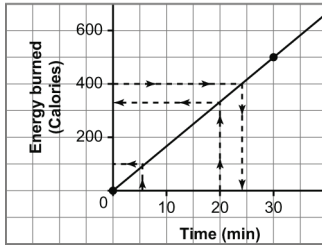
a) Begin at 20 on the *Time* axis. Move vertically to the graph and then horizontally to the *Energy burned*
   axis. After exercising for 20 min, Kendall will burn approximately 330 Calories.

b) Begin at 400 on the *Energy burned* axis. Move horizontally to the graph and then vertically to the *Time*
   axis. Kendall will burn 400 Calories after he exercises for approximately 24 min.

c) Begin at 6 on the *Time* axis. Move vertically to the graph and then horizontally to the *Energy burned*
   axis. After exercising for 6 min, Kendall will burn approximately 100 Calories.

10.
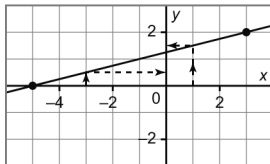
a) Begin at –3 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
   When $x = -3$, y is approximately $\dfrac{1}{2}$.

I can check this approximate answer. From the graph, as x increases by 8, y increases by 2. So, as x increases by 4, y increases by 1. The increase in y is $\frac{1}{4}$ the increase in x. I use this pattern and I know that as x increases by 2 from –5 to –3, then y increases by $\frac{2}{4}$, or $\frac{1}{2}$ from 0. So, when x = –3, y = $\frac{1}{2}$.

b) Begin at 0 on the x-axis and move vertically on the y-axis. When x = 0, y is approximately $\frac{5}{4}$.

I can check this approximate answer. From the graph, as x increases by 5 from –5 to 0, y increases by $\frac{5}{4}$ from 0. So when x = 0, y = $\frac{5}{4}$.

c) Begin at 1 on the x-axis. Move vertically to the graph and then horizontally to the y-axis. When x = 1, y is approximately $\frac{3}{2}$.

I can check this approximate answer. From the graph, as x increases by 6 from –5 to 1, y increases by $\frac{6}{4}$, or $\frac{3}{2}$ from 0. So when x = 0, y = $\frac{3}{2}$.

11.

Graph for Converting Speeds
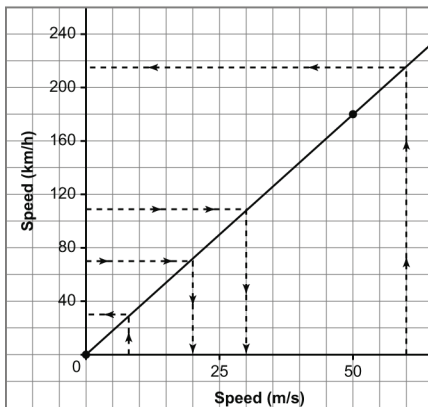
a) i) Begin at 70 km/h on the vertical axis. Move horizontally to the graph and then vertically to the horizontal axis. A speed of 70 km/h is approximately 20 m/s.
ii) Begin at 110 km/h on the vertical axis. Move horizontally to the graph and then vertically to the horizontal axis. A speed of 110 km/h is approximately 30 m/s.

b) i) Extend the graph so the horizontal axis includes 60. Begin at 60 m/s on the horizontal axis. Move vertically to the graph and then horizontally to the vertical axis. A speed of 60 m/s is approximately 220 km/h.
ii) Begin at 8 m/s on the horizontal axis. Move vertically to the graph and then horizontally to the vertical axis. A speed of 8 m/s is approximately 30 km/h.

c) i) I used interpolation to answer both questions in part a and part b, ii. All these questions involved reading data points that were between the plotted points on the graph.
ii) I used extrapolation to answer part b, i, because the given value was beyond the plotted points.

d) My answers are estimates because it is difficult to read the exact value from the graph unless the data points happen to be at the intersection of two grid lines. Since this was not the case for any of the data points for this question, my answers are estimates of the actual values.

12.
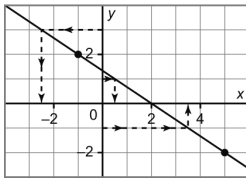
a) Begin at 3 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.

When *y* = 3, *x* is approximately $-\dfrac{5}{2}$.

I can check this approximate answer. From the graph, as *y* increases by 2, *x* decreases by 3. So, as *y* increases by 1, *x* decreases by $\dfrac{3}{2}$. I use this pattern and I know that as *y* increases by 1 from 2 to 3,

then *x* decreases by $\dfrac{3}{2}$ from –1 to $-1 - \dfrac{3}{2} = -\dfrac{5}{2}$. So, when *y* = 3, $x = -\dfrac{5}{2}$

b) Begin at 1 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.

When *y* = 1, *x* is approximately $\dfrac{1}{2}$.

I can check this approximate answer. From the graph, as *y* decreases by 1 from 2 to 1, then *x* increases by $\dfrac{3}{2}$ from –1 to $-1 + \dfrac{3}{2} = \dfrac{1}{2}$ So, when *y* = 1, $x = \dfrac{1}{2}$

c) Begin at –1 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.

When *y* = 5, *x* is approximately $\dfrac{7}{2}$.

I can check this approximate answer. From the graph, as *y* increases by 1 from –2 to –1, then *x* decreases by $\dfrac{3}{2}$ from 5 to $5 - \dfrac{3}{2} = \dfrac{7}{2}$ So, when *y* = –1, $x = \dfrac{7}{2}$

13.

Reece's Pay
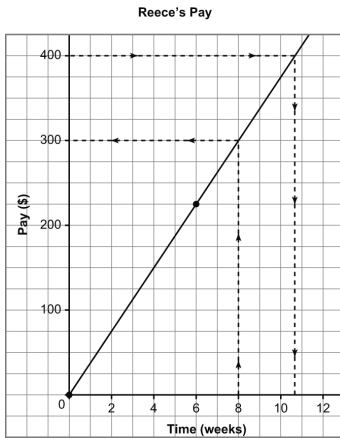
a) Extend the graph so the *Time* axis includes 8 and the *Pay* axis includes 400. Begin at 8 on the *Time* axis. Move vertically to the graph and then horizontally to the *Pay* axis.
After 8 weeks, Reece's earnings will be about $300.

b) Begin at 400 on the *Pay* axis. Move horizontally to the graph and then vertically to the *Time* axis. It will take Reece approximately 11 weeks to earn $400. This is assuming that she continues to work 5 h a week and gets paid at the same rate.

c) Reece could change the number of hours she works in a week or her employer could change her pay.

14.
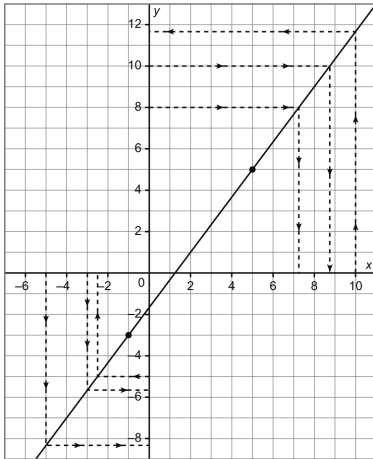
a) Extend the graph to include –3 and 10 on the *x*-axis, and –5 and 10 on the *y*-axis.

i) Begin at –3 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.

When $x = -3$, $y = -\dfrac{17}{3}$

I can check this approximate answer. From the graph, as *x* decreases by 6 from 5 to –1, *y* decreases

by 8 from 5 to –3. So, when *x* decreases by 2, *y* decreases by $\dfrac{8}{3}$. When $x = -1$, $y = -3$, so when

$x = -3$, $y = -3 - \dfrac{8}{3}$, or $-\dfrac{17}{3}$.

ii) Begin at –5 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.

When $x = -5$, $y = -\dfrac{25}{3}$

I can check this approximate answer. From the graph, as *x* decreases by 6 from 5 to –1, *y* decreases

by 8 from 5 to –3. So, when *x* decreases by 2, *y* decreases by $\dfrac{8}{3}$. When $x = -1$, $y = -3$, so when

$x = -5$, $y = -3 - 2 \times \dfrac{8}{3}$, or $-\dfrac{25}{3}$.

iii) Begin at 10 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.

When $x = 10$, $y = \dfrac{35}{3}$

I can check this approximate answer. From the graph, as *x* increases by 6 from –1 to 5, *y* increases

by 8 from –3 to 5. So, when *x* increases by 1, *y* increases by $\dfrac{8}{6} = \dfrac{4}{3}$. When $x = 5$, $y = 5$, so when $x =$

10, $y = 5 + 5 \times \dfrac{4}{3}$, or $\dfrac{35}{3}$.

b) i) Begin at –5 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
When $y = -5$, $x = -2.5$
I can check this approximate answer. From the graph, as *y* decreases by 8 from 5 to –3, *x* decreases

by 6 from 5 to –1. So, when *y* decreases by 2, *x* decreases by $\dfrac{6}{4} = \dfrac{3}{2}$. When $y = -3$, $x = -1$, so when

$y = -5$, $x = -1 - \dfrac{3}{2}$, or –2.5.

ii) Begin at 8 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.

When *y* = 8, *x* = 7.25

I can check this approximate answer. From the graph, as *y* increases 8 from –3 to 5, *x* increases by 6

from –1 to 5. So, when *y* increases by 1, *x* increases by $\frac{6}{8} = \frac{3}{4}$. When *y* = 5, *x* = 5, so when *y* = 8,

x = 5 + 3 × $\frac{3}{4}$, or $\frac{29}{4}$ = 7.25.

iii) Begin at 10 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.

When *y* = 10, *x* = 8.75.

I can check this approximate answer. From the graph, as *y* increases 8 from –3 to 5, *x* increases by 6

from –1 to 5. So, when *y* increases by 1, *x* increases by $\frac{6}{8} = \frac{3}{4}$. When *y* = 5, *x* = 5, so when *y* = 10,

x = 5 + 5 × $\frac{3}{4}$, or $\frac{35}{4}$ = 8.75.

Take It Further

15. a)
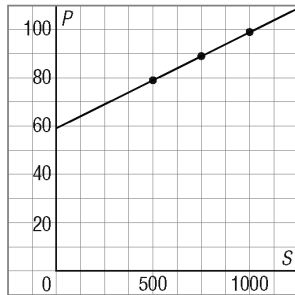
b) Extend the graph in part a to include 1400 on the *Size* axis. Begin at 1400 on the *Size* axis. Move vertically to the line and then horizontally to the *Price* axis. The owner should charge approximately $1.15 for a 1400-mL drink.
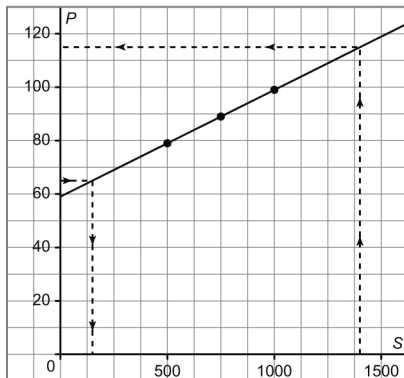
c) Begin at 65 on the *Price* axis. Move horizontally to the graph and then vertically to the *Size* axis. A drink that cost $0.65 should be approximately 150 mL.

Review	(pages 201–203)

Lesson 4.1

1. a) The perimeter is the sum of the measures of all sides.

Figure 1 has perimeter 10.
Figure 2 has perimeter 14.
Figure 3 has perimeter 18.
Figure 4 has perimeter 22.

b)

Figure 5   Figure 6   Figure 7
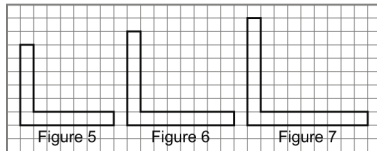
c)

Figure Number, n	Perimeter, P
1	10 = 4(1) + 6
2	14 = 4(2) + 6
3	18 = 4(3) + 6
4	22 = 4(4) + 6
5	26 = 4(5) + 6
6	30 = 4(6) + 6
7	34 = 4(7) + 6

d) As the figure number increases by 1, the perimeter increases by 4.
Since $P = 10$ when $n = 1$, the perimeter is 4 times the figure number, plus 6.
An expression is: $4n + 6$

e) An equation is: $P = 4n + 6$

f) Substitute $n = 30$ in the equation $P = 4n + 6$.
$P = 4(30) + 6$
   $= 120 + 6$
   $= 126$
The perimeter of figure 30 is 126 units.

g) Substitute $P = 90$ in the equation $P = 4n + 6$, then solve for n.

$90 = 4n + 6$	Subtract 6 from each side.
$90 - 6 = 4n + 6 - 6$	
$84 = 4n$	Divide each side by 4.

$$\frac{84}{4} = \frac{4n}{4}$$

$21 = n$
Figure 21 has perimeter 90 units.

2. a) As n increases by 1, v increases by 3.

Term number, n	Term value, v
1	$-5 = 3(1) - 8$
2	$-2 = 3(2) - 8$
3	$1 = 3(3) - 8$
4	$4 = 3(4) - 8$

b) When $n = 1$, $v = -5$, so we subtract 8 to describe the term value, v, correctly. An expression is: $3n - 8$

c) An equation is: $v = 3n - 8$

d) Substitute $n = 2$ and $v = -2$ in the equation $v = 3n - 8$.

Left side: $v = -2$ Right side: $3n - 8 = 3(2) - 8$

$= -2$

Since the left side is equal to the right side, the equation must be correct.

e) Substitute $n = 21$ in the equation $v = 3n - 8$.

$v = 3n - 8$

$= 3(21) - 8$

$= 63 - 8$

$= 55$

The 21st term is 55.

f) Substitute $v = 106$ in $v = 3n - 8$, then solve for n.

$v = 3n - 8$

$106 = 3n - 8$ Add 8 to each side.

$106 + 8 = 3n - 8 + 8$

$114 = 3n$ Divide each side by 3.

$\dfrac{114}{3n} = \dfrac{3n}{3}$

$38 = n$

The 38th term has a value of 106.

To check, substitute $n = 38$ in the equation.

$v = 3n - 8$

$= 3(38)n - 8$

$= 114 - 8$

$= 106$

Since this equals the original value for v, my answer is correct.

3. a)

Term Number, n	Term Value, v
1	$75 = 79 - 4(1)$
2	$71 = 79 - 4(2)$
3	$67 = 79 - 4(3)$
4	$63 = 79 - 4(4)$
5	$59 = 79 - 4(5)$
6	$55 = 79 - 4(6)$
7	$51 = 79 - 4(7)$

b) An expression is: $79 - 4n$

Lesson 4.2

4. a)

Time, t (months)	Account Balance, A ($)
0	140 = 20(0) + 140
1	160 = 20(1) + 140
2	180 = 20(2) + 140
3	200 = 20(3) + 140
4	220 = 20(4) + 140
5	240 = 20(5) + 140
6	260 = 20(6) + 140
7	280 = 20(7) + 140

b)
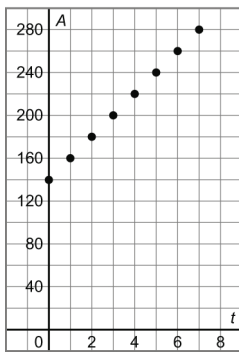
No, I will not join the points. Since the deposits are monthly, points reflect discrete values.

c) Yes, the relation is linear because all the points lie on a straight line.

d) In the table, as t increases by 1, A increases by 20.
On the graph, as we move 1 unit right we move 20 units up.

e) An equation is: $A = 20t + 140$

5. a) $y = 4x$

x	y
1	4
2	8
3	12

As x increases by 1, y increases by 4.

b) $y = 10 - 2x$

x	y
0	10
1	8
2	6

As x increases by 1, y decreases by 2.

c) $y = 3x + 4$

x	y
−3	−5
−2	−2
−1	1

As x increases by 1, y increases by 3.

6. a)
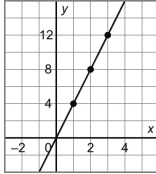
In the graph, as x increases by 1, y increases by 4.
On the graph, as we move 1 unit right, we move 4 units up.

b)
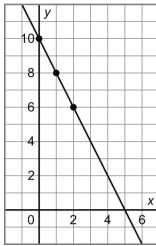
In the table, as x increases by 1, y decreases by 2.
On the graph, as we move 1 unit right, we move 2 units down.

c)
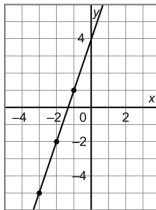
In the table, as x increases by 1, y increases by 3.
On the graph, as we move 1 unit right, we move 3 units up.

Lesson 4.3

7. a) Let l and m represent the two lengths of string.

l	m
25	0
20	5
15	10
10	15
5	20
0	25

b) i) The relation is linear because all the points lie on a straight line.
  ii) The points should be connected because each string could be any length between the plotted values.
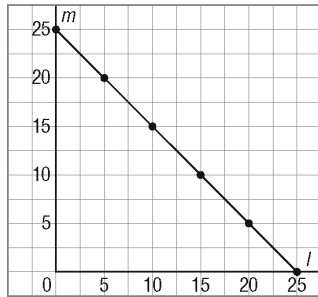
c) i) Since the length of both strings combined is 25 cm, an equation is: $l + m = 25$.
  ii) I can check this equation by substituting $l = 15$ and $m = 10$ into $l + m = 25$.
    Left side: $l + m = 15 + 10$ Right side: 25
                              = 25
    Since the left side is equal to the right side, the equation is correct.

8. A table of values is not required for any equation. The equations contain only one variable and so describe either horizontal or vertical lines.

a) The graph is a vertical line that intersects the *x*-axis at –2.
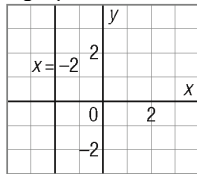
b) The graph is a horizontal line that intersects the *y*-axis at 3.
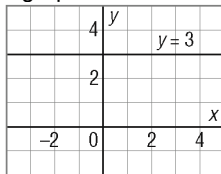
c) The graph is a vertical line that intersects the *x*-axis at 5.
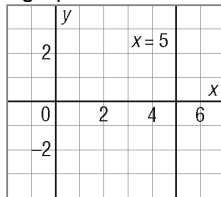
d) The graph is a horizontal line that intersects the *y*-axis at –1.
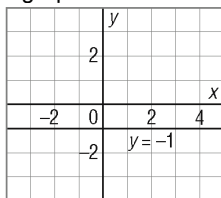
9.

a) $3x + y = 9$

x	y
–3	18
0	9
3	0
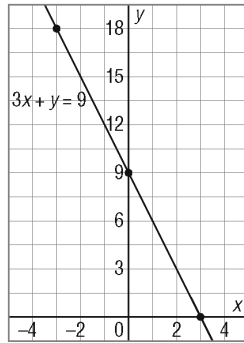
b) $2x – y = 4$

x	y
–2	–8
0	–4
2	0
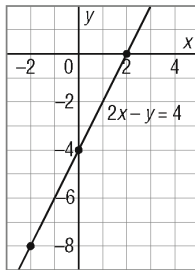
c) $2x + y = –6$

x	y
–4	2
0	–6
4	–14
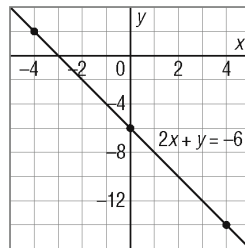
d) $x – 2y = –6$

x	y
–2	2
0	3
2	4
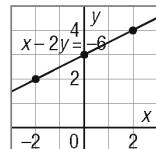
10. a) The equation $x = 6$ describes a vertical line since every point on the line has x-coordinate 6.

b) The equation $x – y = 3$ describes an oblique line since it has both an x- and a y-term.

c) The equation $y + 8 = 0$ describes a horizontal line since it can be written as $y = –8$, and every point on this line has y-coordinate –8.

d) Solve for x.

$2x + 9 = 0$ Subtract 9 from each side.

$2x + 9 – 9 = 0 – 9$

$2x = –9$ Divide both sides by 2.

$\dfrac{2x}{2} = \dfrac{–9}{2}$

$x = –4.5$

The equation $2x + 9 = 0$ describes a vertical line since it can be written as $x = –4.5$, and every point on this line has x-coordinate –4.5.

Lesson 4.4

11. 2 points on the graph are (0, –2) and (–2, 4). Check to see if their coordinates satisfy the equation.

Substitute $x = 0$ and $y = -2$ in $y = -2x + 3$.

Left side: –2   Right side: –2(0) + 3 = 0 + 3

                                                    = 3

Since the left side does not equal the right side, this equation does not describe the graph.

Substitute $x = 0$ and $y = -2$ in $y = 2x + 3$.

Left side: –2   Right side: 2(0) + 3 = 0 + 3

                                                  = 3

Since the left side does not equal the right side, this equation does not describe the graph.

Substitute $x = 0$ and $y = -2$ in $y = 3x - 2$.

Left side: –2   Right side: 3(0) – 2 = 0 – 2

                                                  = –2

Since the left side does not equal the right side, this equation does not describe the graph.

Substitute $x = 0$ and $y = -2$ in $y = -3x - 2$

Left side: –2   Right side: –3(0) – 2 = 0 – 2

                                                    = –2

The left side equals the right side so the point satisfies the equation.

Substitute $x = -2$ and $y = 4$ in $y = -3x - 2$

Left side: 4   Right side: –3(–2) – 2 = 6 – 2

                                                      = 4

The left side equals the right side so the point satisfies the equation.

Since both pairs of coordinates satisfy the equation, equation d, $y = -3x - 2$, describes the graph.

12. I generated 3 points for the relation $x - 2y = 4$, and all of them lie on Graph B.

$x - 2y = 4$

x	y
–2	–3
0	–2
2	–1

13. a) I found the coordinates of 3 points that lie on the line with equation $x + 2y = 6$.

All the points lie on Graph iii.

$x + 2y = 6$

x	y
–2	4
0	3
2	2

b) I found the coordinates of 3 points that lie on the line with equation $y = x - 3$.

All the points lie on Graph i.

$y = x - 3$

x	y
–2	–5
0	–3
2	–1

c) I found the coordinates of 3 points that lie on the line with equation $y = 2x - 3$.
All the points lie on Graph iv.

$y = 2x - 3$

x	y
−2	−7
0	−3
2	1

d) I found the coordinates of 3 points that lie on the line with equation $y = -4x + 5$.
All the points lie on Graph ii.

$y = -4x + 5$

x	y
0	5
1	1
2	−3

Lesson 4.5

14 Copy the graph. Extend the x-axis to include 2.5 m^3 and the y-axis to include 2000 kg.

Mass against Volume for Wheat
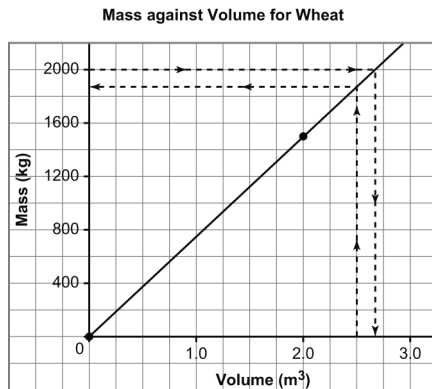
a) Begin at 2000 on the y-axis. Move horizontally to the graph and then vertically to the x-axis.
2000 kg of wheat is about 2.6 m^3.

b) Begin at 2.5 on the x-axis. Move vertically to the graph and then horizontally to the y-axis.
2.5 m^3 of wheat is about 1950 kg.

15. a) Estimate where the graph intersects either the x- or the y-axis.
Medicine Hat is about 1035 km from Winnipeg.

b) Begin at 450 on the *Distance from Medicine Hat* axis. Move vertically to the graph and then horizontally to the *Distance to Winnipeg* axis.
Jenny and Harold have travelled about 590 km.

16. a) Copy the graph. Extend the *x*-axis to 1800.

Gas Consumption
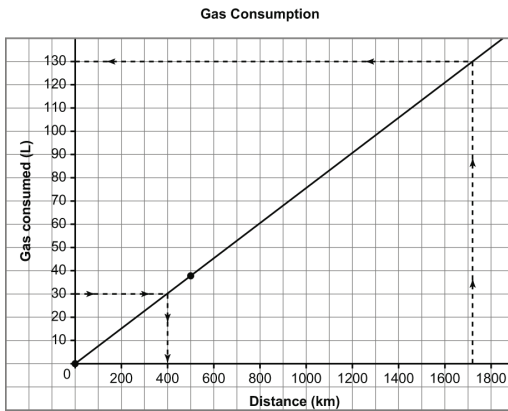
Begin at 1720 on the *x*-axis. Move vertically to the graph and horizontally to the *y*-axis.
The volume of gas needed to travel from Regina to Vancouver is about 130 L.

b) Begin at 30 on the y-axis. Move horizontally to the graph and then vertically to the x-axis.
When the car has used about 30 L of gasoline it has travelled about 400 km.

17. Copy the graph. Extend the *x*-axis to include –4 and 5 and the *y*-axis to include –3 and 7.
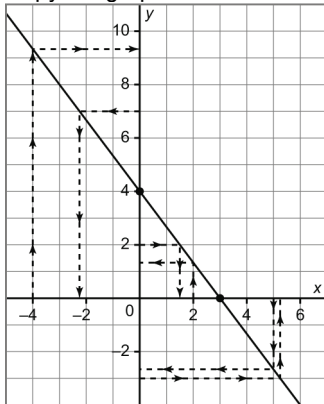
a) i) Begin at –4 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
When $x = -4$, $y = \dfrac{28}{3}$, or $9\dfrac{1}{3}$

ii) Begin at 2 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
When $x = 2$, $y = \dfrac{4}{3}$, or $1\dfrac{1}{3}$

iii) Begin at 5 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
When $x = 5$, $y = -\dfrac{8}{3}$, or $-2\dfrac{2}{3}$

b) i) Begin at 7 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
When $y = 7$, $x = -2.25$

ii) Begin at 2 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
When $y = 2$, $x = 1.5$

iii) Begin at –3 on the *y*-axis. Move horizontally to the graph and then vertically to the *x*-axis.
When $y = -3$, $x = 5.25$

1. a)

Figure Number, f	Number of Square Tiles, s
1	5 = 5(1)
2	10 = 5(2)
3	15 = 5(3)
4	20 = 5(4)

b) As the figure number increases by 1, the number of squares increases by 5. The number of squares is 5 times the figure number. An expression is: $5f$.

c) An equation is $s = 5f$.
Substitute $f = 2$ and $s = 10$ in the equation $s = 5f$.
Left side = 10   Right side = 5(2)
                                                         = 10
Since the left side equals the right side, the equation is correct.

d) Both the expression and the equation involve variables. The expression generates a value when the value of the variable f is known. The equation is a statement that two expressions are equal. The equation generates a value when either f or s is known.

e) Substitute $s = 225$ into $s = 5f$, then solve for f.
$225 = 5f$ Divide both sides by 5.
$$\frac{225}{5} = \frac{5f}{5}$$
$$45 = f$$
Figure 45 has 225 tiles.

2.

a)

x	y
−2	11
0	7
1	5
3	1
5	−3

b)

c) In the table, as x increases by 1, y decreases by 2. On the graph, as we move 1 unit right, we move 2 units down.

3. a) The equation $x = 6$ describes a vertical line since all points on the line have x-coordinate 6.

b) The equation $2y - 7 = 3$ describes a horizontal line since it can be written as: $2y = 10$
$$\frac{2y}{2} = \frac{10}{2}$$
$$y = 5$$

All points on this line have y-coordinate 5.

c) The equation $2x + 9 = 0$ describes a vertical line since it can be written as:

$$2x + 9 = 0$$
$$2x + 9 - 9 = 0 - 9$$
$$2x = -9$$
$$\frac{2x}{2} = \frac{-9}{2}$$
$$x = -4.5$$

All points on this line have x-coordinate –4.5.

4. a) I generated 3 points for $y = x + 3$.

$y = x + 3$

x	y
0	3
1	4
2	5

In the table, as x increases by 1, y increases by 1. I look for the graph where, as I move 1 unit right, I move 1 unit up. This matches graph i.

b) The equation $y = 3$ describes a horizontal line where every point has y-coordinate 3.
This matches graph ii.
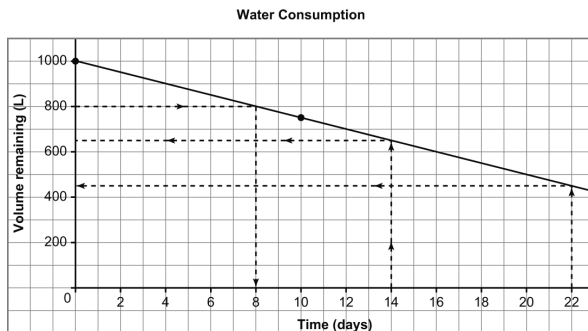
c) I generated 3 points for $x + y = 3$.

$x + y = 3$

x	y
0	3
1	2
2	1

In the table, as x increases by 1, y decreases by 1. I look for the graph where, as I move 1 unit right, I move I unit down. This matches graph iv.

d) The equation $x = -3$ describes a vertical line where every point has x-coordinate –3.
This matches graph iii.

5.

Water Consumption

a) When 200 L have been used, 800 L are left. Begin at 800 on the y-axis. Move horizontally to the graph and then vertically to the x-axis. 800 L are left after 8 days.

b) Copy the graph. Extend the x-axis to include 22 days. Begin at 22 on the x-axis. Move vertically to the graph and then horizontally to the y-axis. Approximately 450 L of water is in the cistern after 22 days.

c) Begin at 14 on the x-axis. Move vertically to the graph and then horizontally to the y-axis. 650 L are remaining after 14 days. 1000 L – 650 L = 350 L so, approximately 350 L is used in the first 14 days.

d) I assume that the family continues to use water at a constant rate and no water was added to the cistern.

Part 1

a)

Sales of Cassette Tapes in North America
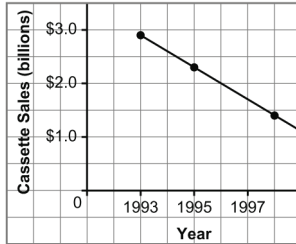
The graph represents a linear relation because all the points lie on a straight line.

b) Since the data are linear, the change in sales per year is constant. The change over two years, from 1993 to 1995, is 2.3 – 2.9 = –0.6. So, the change over one year is $\dfrac{-0.6}{2}$, or –0.3 billion dollars. Cassette sales decrease by $0.3 billion every year from 1993.

c)

Year	Number of Years Since 1993, t	Cassette Sales, S (billions $)
1993	0	2.9 = –0.3(0) + 2.9
1994	1	2.6 = –0.3(1) + 2.9
1995	2	2.3 = –0.3(2) + 2.9
1996	3	2.0 = –0.3(3) + 2.9
1997	4	1.7 = –0.3(4) + 2.9
1998	5	1.4 = –0.3(5) + 2.9

Cassette sales decrease by $0.3 billion each year. We can write this as $S = = -0.3t$, however, since $S = 2.9$ when $t = 0$, we add 2.9 to describe the sales correctly. An equation is: $S = -0.3t + 2.9$

d) 1997 is 4 years after 1993, so substitute $t = 4$ in the equation $S = -0.3t + 2.9$.
$S = -0.3t + 2.9$
  $= -0.3(4) + 2.9$
  $= -1.7 + 2.9$
  $= 1.7$
Sales in 1997 were $1.7 billion.

From the graph, begin at 1997 on the x-axis. Move vertically to the graph and then horizontally to the y-axis. There were $1.7 billion sales in 1997. This value agrees with the answer from the equation because the graph describes the equation $S = -0.3t + 2.9$.

e) Extend the graph until the line crosses the *x*-axis.

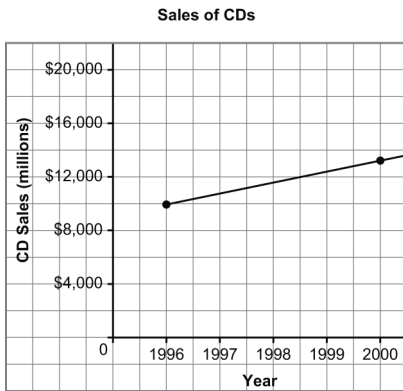**Sales of Cassette Tapes in North America**
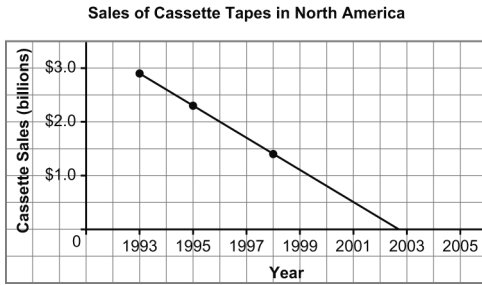
Sales of cassette were $0 in 2003.

f) To predict when sales would reach $0, I extrapolate. When I extrapolate, I assume that the sales continue to describe a linear pattern. In this situation, the pattern must have changed after 1998.

Part 2

a)

Sales of CDs

Begin at 1997 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
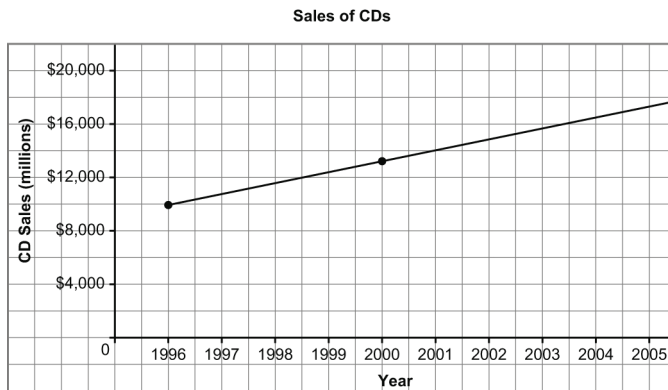The sales of CDs in 1997 was about $11 000 million.

Begin at 1998 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
The sales of CDs in 1998 was about $11 500 million.

Begin at 1999 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
The sales of CDs in 1999 was about $12 500 million.

This is interpolation as I am reading the data that lies between the plotted points.

b) I add the sales for each year, in millions of dollars: 11 000 + 11 500 + 12 500 + 9 935 + 13 215 = 58 150.
The total CD sales for the 5-year period was about $58 000 million.

c) Extend the graph to include 2001 on the *x*-axis.

Sales of CDs

Begin at 2001 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis.
The sales of CDs in 2001 was about $14 000 million. This is extrapolation since we have to extend the graph past the plotted points.

d) Extend the graph to include 2005 on the *x*-axis. Begin at 2005 on the *x*-axis. Move vertically to the graph and then horizontally to the *y*-axis. The sales of CDs in 2005 was about $17 000 million

e) My answer to part c is more likely closer to the actual value since I am making a prediction that lies 1 year beyond my last plotted point. To make my prediction for part d, I am 5 years beyond my last plotted point. When I extrapolate, the closer I am to the actual data the more confidence I have in the prediction.