(f) First Differences 33.1, 23.3, 13.5, 3.7, -6.1, -15.9; nonlinear;
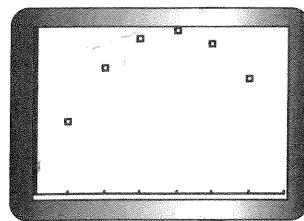
2. (a) 9.8 m/s^2 **(c)** 1.5 \$/km
**(d)** -950 \$/year

Interpolating and Extrapolating, page 239

**1. (a)** 53 m and 54 m **(b)** 73 m and 77 m
2. (a)
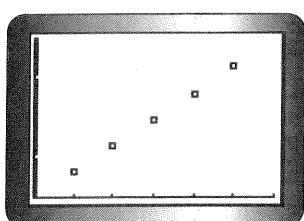
(b) 24.5 m/s, 34.3 m/s, 46.55 m/s
(c) 58.8 m/s, 88.2 m/s, 98 m/s
3. Extrapolation is a prediction based on the data while interpolation is taken directly from the data.
4. Find the equation for the line of best fit, then substitute in your y$-$value.
5. (a) Mass of Object (kg): 0, 1, 2, 3, 4, 6, **10**, 12
  Kinetic Energy (J): 0, 48.02, 96.04, **144.06, 192.08,** 288.12, 480.2, **576.24**
(b)
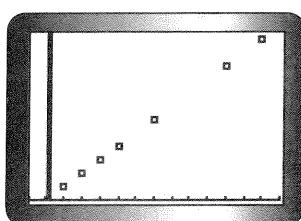

(c) 240.1 J
(d) 11.45 kg
6. (a)
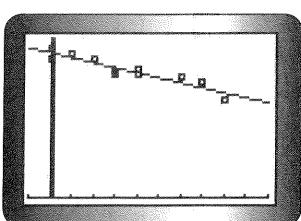
(b) The average for 0 absences is 90%. For every time absent, the average mark drops by about 3%.

(c) 72%
(d) 13 days missed

# Chapter 3

Getting Ready, page 244

1. (a) x-intercept $\frac{5}{3}$, y-intercept 5
  (b) x-intercept 2, y-intercept -5
  (c) x-intercept -2, y-intercept 4
  (d) x-intercept 4, y-intercept -5
2. (a) yes   **(b)** yes   **(c)** yes
3. (a) 250   **(b)** 12   **(c)** -28
  (d) 414   **(e)** 275   **(f)** 92.5
  (g) 2   **(h)** -0.9 **(i)** -5
  (j) $\frac{-3}{8}$ **(k)** -25 **(l)** 2
  (m) $\frac{-1}{12}$
4. (a) $-3x + 5y$ **(b)** $-7ab - 3bc$ **(c)** $-2x^2 + 7$
  (d) $5m - 21$ **(e)** $-5y + 12$ **(f)** $-2w^2 + 16w$
  (g) $2x^5 - 5x^2$ **(h)** $10x^6 - 15x^5$ **(i)** $-16x^6 - 8x^5$
5. (a) linear, $x = 0.5$
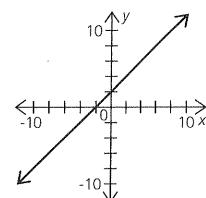
(b) linear, $x = \frac{7}{6}$
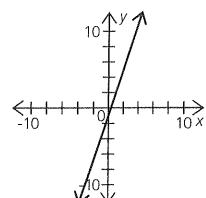
(c) nonlinear, $x = \pm 2.1$

(d) nonlinear, $x = 20.25$

6. (a) 432 **(b)** 755
(c) 40.5 **(d)** 55.97
(e) 84 **(f)** 0

7. (a) $x = \frac{7}{2}, x = \frac{5}{2}, x = 11, x = -\frac{19}{3}$

(b) $a = 1, a = -\frac{1}{3}$, no solution, $a = 0.8$

8. (a) $a = 3$ **(b)** $b = -\frac{25}{2}$

(c) $c = -3$ **(d)** $d = 1$

(e) $e = \frac{6}{5}$ **(f)** $f = 11$

9. (a) $2w\,(8 - w)$ **(b)** $4\,(x + 5)\,(x - 2)$
(c) $2x^2\,(x^2 + 2x + 4)$ **(d)** $5xy(xy - 3 + 4x^2y)$

10. (a) Let x be length in centimetres. Let y be width in centimetres. $2x + 2y = 100$.

(b) Let x be side length in metres. $4x = 36$

(c) Let x, y, z be the lengths of the sides in centimetres. $x + y + z = 13$

(d) Let x be the width in centimetres. Let y be the length in centimetres. $xy = 40$

(e) Let x be the side length in centimetres. $x^2 = 81$

(f) Let x be the length of the base. $\frac{1}{2}x^2 = 14$

(g) Let x and y be the lengths of the sides of the large rectangle in centimetres. Let A be the area. $xy - 100 = A$

(h) Let x and y be the dimensions of the floor in centimetres. Let N be the number of tiles needed. $\frac{xy}{100} = N$

(i) Let x be the volume of gas in the storage tank in litres. Let y be the number of cans filled. $\frac{x}{5} = y$

**(j)** Let x be the distance driven in km. Let y be the cost in dollars. $0.059\,31x = y$

Practise, Apply, Solve 3.1, page 254

1. (a) 9, 9 **(b)** $-3, 93$
(c) 4, -74 **(d)** 21, 15
(e) $-1, -25$ **(f)** 15, 0
2. (a) linear **(b)** nonlinear
(c) nonlinear, quadratic **(d)** nonlinear
(e) nonlinear **(f)** nonlinear
3. (a) 2
4. (a) 7, 4, 1, $-5, -8$
(b) 8, 5, 5, 8; $-3, -1, 3$
(c) $-15, -2, 3, 7, 10; 7, 5, 4$
5. (a) 1 **(b)** 2 **(c)** 1
(d) 2 **(e)** 2 **(f)** 3
(g) 2 **(h)** 2 **(i)** 5
(j) 3 **(k)** 1 **(l)** 2
6. b, d, e, g, h, l

**7. (a)**

(b)


(c)


(d)

8. (a) (b)
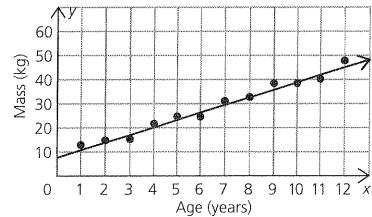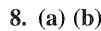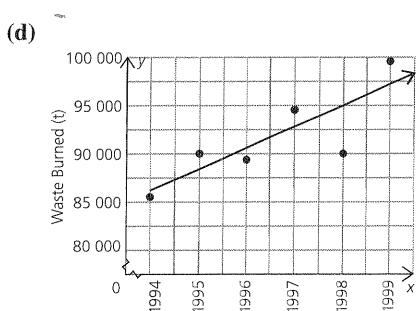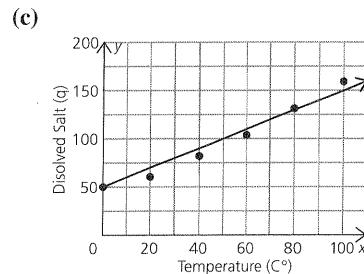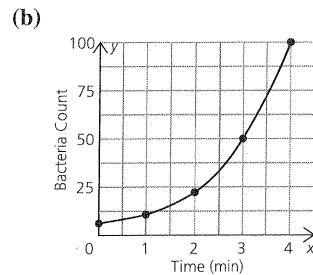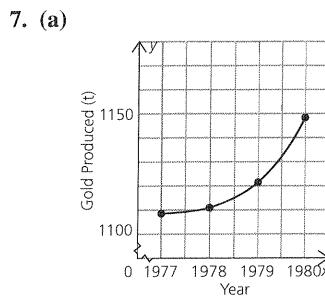
(c) linear - close to a line with some variations
(d) The model is reasonably accurate.

9. (a)–(b)
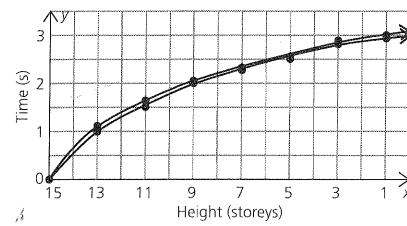
(c) very good fit   (d) nonlinear

10. (a)
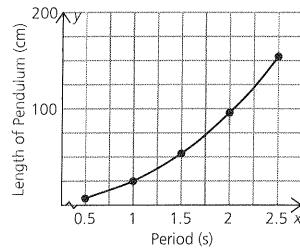
(b) 1.35 s   (c) 120 cm
(d) quadratic (second differences equal)

11. (a)
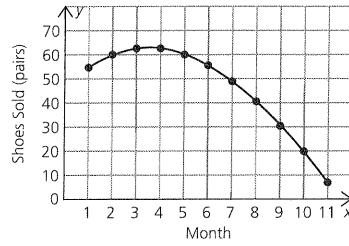
(b) months 3-4
(c) There were less shoes sold - new types of shoes to buy
(d) months 1-2: +4, months 4-5, −2; sales increasing in months 1-2 and decreasing in months 4-5
(e) months 1-2: +4, months 2-3, +2; sales increasing faster in months 1-2 than in months 2-3
(f) months 4-5: −2, months 5-6: −4; sales decreasing faster in months 5-6 than in months 4-5
(g) The second differences are equal.

12. (a) (c)
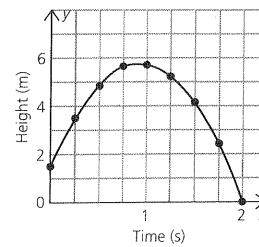
(b) quadratic
(d) 0.9 s, 5.8 m   (e) 2 s

13.(a)

Shape	Width(cm)	Length(cm)	Area(cm²)
	1	2	2
	2	4	8
	3	6	18
	4	8	32
	5	10	50
	6	12	72

(b) nonlinear (first differences are not equal)
(c) yes, the relation is quadratic
(d) Area $= 2$(width)^2; degree $= 2$

14. (a) 8 by 8, 10 by 10
(b) 64, 100
(c) nonlinear
(d) quadratic (second difference is constant)
(e)
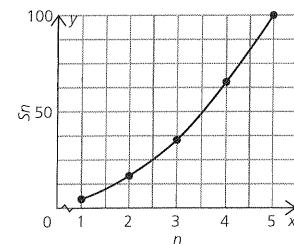
(f) $S_n = 4n^2$; degree $= 2$

15. (b)

Number of points	Number of connecting line segments
2	1
3	3
4	6
5	10

(c)
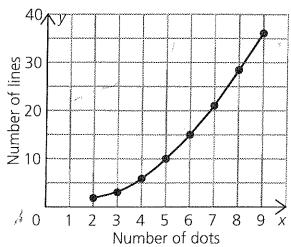
(d) nonlinear - first differences are not identical

(e) number of lines $= \frac{n(n-1)}{2}$ where n is the number of dots

**(f)** 21

(g) substitute 21 into equation in (e)

16. (a) quadratic (parabola)

(b)
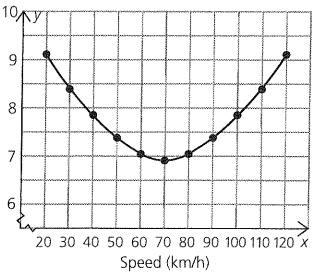
(c) 70 km/h

(d) more strain on engine - more gas used

(e) $6; 2.57 h longer

17. linear - first differences close to equal, quadratic - second differences close to equal, other, large fluctuations with some pattern

18. 59 900

19. (a)
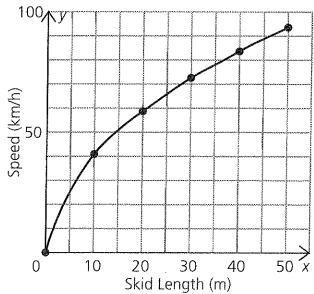
(b) 94.1 m

(c) 36 m

**(d)** maximum skid length would be 32.4 m

(e) 69 m

(f) different material would have a different frictional coefficient while moisture conditions would increase the skid length

Practise, Apply, Solve 3.2, page 266

1. (a) no **(b)** yes **(c)** no
(d) no **(e)** yes **(f)** no
(g) yes **(h)** no

2. (a) down **(b)** up **(c)** down
(d) up

3. (a) (3, 2) **(b)** 2
(c) $x = 3$ **(d)** $x = 0, x = 6$
(e) negative

4. (a) (2, −3) **(b)** −3 (minimum)
(c) $x = 2$ **(d)** $x = 0$ or $x = 4$
(e) positive (slope is strictly increasing)

5. (a) minimum **(b)** 2.5
(c) negative (is a minimum and the graph has 2 intersections with the x-axis)

6. (a) maximum **(b)** 7.5 **(c)** positive

7. (a) $x = 0$ or $x = 20$ **(b)** $x = 0$ or $x = 12$
(c) $x = 0$ or $x = 2$ **(d)** $x = 0$ or $x = 18$
(e) $x = 0$ or $x = -\frac{6}{5}$ **(f)** $x = 0$ or $x = \frac{16}{3}$

8.
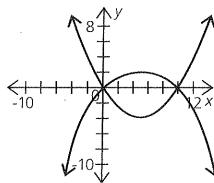
9. (a) $w(15 - w)$; $x = 0$ or $x = 15$; $x = 7.5$
(b) $L(24 - L)$; $x = 0$ or $x = 24$; $x = 12$
(c) $2x(x - 5)$; $x = 0$ or $x = 5$; $x = 2.5$
(d) $x(15 - 2x)$; $x = 0$ or $x = \frac{15}{2}$; $x = \frac{15}{4}$

10. (a) $x = 6$ **(b)** $x = -5.5$ **(c)** $x = -3.5$
(d) $x = 7.75$ **(e)** $x = -0.75$ **(f)** $x = -3$
(g) $x = \frac{17}{8}$ **(h)** $x = \frac{s + t}{2}$

11. (a) zeros at $x = 0$, $x = 5$; football hits ground after 5 s
(b) (2.5, 31.25)
(c)
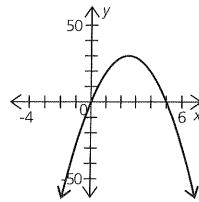
(d) The maximum height of 31.25 m occurs after 2.5 s.

12. (a)
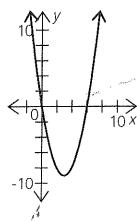
(b) $y = (x - 3)^2 - 9$

13. shift and stretch the graph of $y = x^2$.

14. (a)
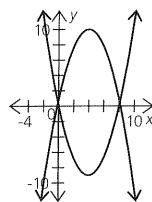
(b) $y = \frac{5}{8}(x - 4)^2 - 10$, $y = -\frac{5}{8}(x - 4)^2 + 10$

(c) positive coefficient = opens up, negative coefficient = opens down

15. 100 m

**16.** 30 m: $2x + y = 30$, xy = maximum, maximum area = 112.5 m²; 50 m: $2x + y = 50$, xy = maximum, maximum area = 312.5 m²; 70 m: $2x + y = 70$, xy = maximum, maximum area = 612.5 m²

17. (a) The x-coordinate of the vertex is half way between the zeros; substitute this for x.

(b) positive second differences = minimum, negative second differences = maximum

(c) Set each factor to 0 and solve the resulting equations.

(d) optimal value = y-coordinate of the vertex

18. 2.45

Practise 3.3, page 272

(a) $-4, -1$ **(b)** $9, -7$ **(c)** $3, -3$

(d) $\frac{2}{3}, -6$ **(e)** $\frac{1}{4}, \frac{3}{5}$ **(f)** $\frac{1}{2}, -5$

Practise, Apply, Solve 3.4, page 280

1. (a) 5, 30   **(b)** $-50, 50$

   (c) $-4, 1$ **(d)** $-5, -1$

   (e) none   **(f)** none

2. (a) $x = 17.5$ **(b)** $x = 0$

   (c) $x = -1.5$ **(d)** $x = -3$

   (e) $x = 0$ **(f)** $x = 2.5$

3. (a) ii   **(b)** iii

   (c) i   **(d)** iv

   (e) vi   **(f)** v

4. (a) maximum

   (b) minimum

   (c) maximum

   (d) minimum

5. (a) $-4, -2$; $x = -3$, $(-3, -1)$

(b) $-5, 2$; $x = -\frac{3}{2}$; $\left(\frac{-3}{2}, \frac{49}{4}\right)$

(c) $-4, -1$; $x = -2.5$; $(-2.5, -2.25)$

(d) $1, -3$; $x = -1$; $(-1, 4)$

(e) $3, 2$; $x = 2.5$; $(2.5, 0.25)$

(f) $-1, 4$; $x = 1.5$; $(1.5, -6.25)$

(g) $-1, 3$; $x = 1$; $(1, -12)$

(h) $-3, 3$; $x = 0$; $(0, 18)$

6. (a) zeros 10, -10; optimal value 600

(b) zeros 7.5, -8; optimal value 480.5

(c) zeros 16, -12.5; optimal value 101.5

(d) zeros 8, -3; optimal value 2268.75

(e) zeros 8, -4; optimal value 800.25

7. (a)
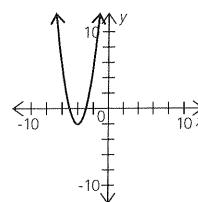
(b)
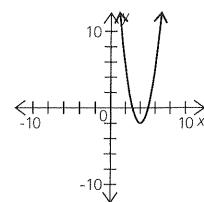
(c)
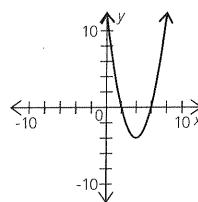
(d)
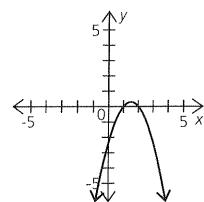
(e)
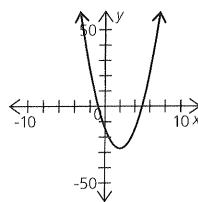

(f)
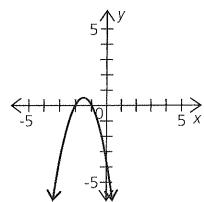
(g)
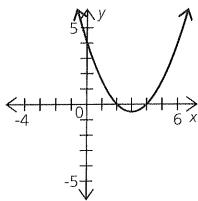
(h)
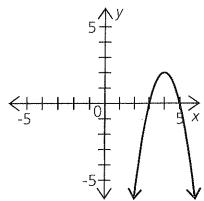
(i)
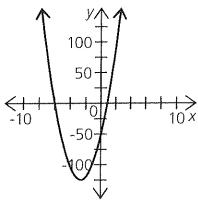
8. (a) $a = \dfrac{5}{9}$ (b) $a = -\dfrac{1}{8}$

    (c) $a = \dfrac{1}{8}$ (d) $a = \dfrac{8}{5}$ (e) $a = -\dfrac{3}{8}$

9. (a) $y = -\dfrac{5}{8}(x + 2)(x - 4)$, down

    (b) $y = \dfrac{5}{8}(x + 2)(x - 4)$, up

    (c) $y = \dfrac{2}{5}(x + 2)(x + 5)$, up

    (d) $y = -\dfrac{2}{5}(x + 2)(x + 5)$, down

    (e) $y = \dfrac{1}{4}(x - 3)(x - 8)$, up

    (f) $y = -\dfrac{1}{4}(x - 3)(x - 8)$, down

10. (a) (b)
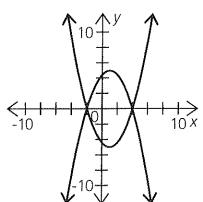
(c) (d)
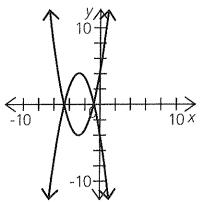
(e) (f)
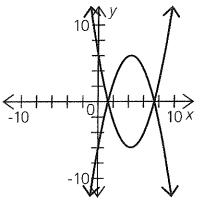
11. (a) $y = -\dfrac{3}{2}(x - 3)(x - 7)$

    (b) $y = \dfrac{8}{25}(x + 1)(x + 6)$

    (c) $y = -\dfrac{5}{16}(x + 1)(x - 7)$

    (d) $y = -\dfrac{2}{9}x(x + 9)$

12. (a) $x = 1$

    (b) $y = 2(x + 3)(x - 5)$

    (c) $(1, -32)$

    (d)
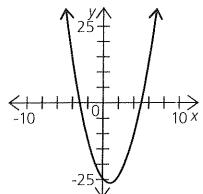
13. (c) $x = -1$

    (d) $x = -1, x = 5$

    (e) $(2, 45)$

    (f) $y = -5(x + 1)(x - 5)$

    (g) $x = 5$ is the time when the ball hits the ground. $x = -1$ is point where the ball would have started from is thrown from the ground.

14. At 15 m from the hole, the ball is 5.1 m above ground. $\left(y = -\dfrac{1}{250}(x + 50)(x - 50)\right)$, letting origin be the base of the tree.

15. $y = -\dfrac{3}{10}x^2 + 100$

16. $y = -0.004(x + 140.5)(x - 140.5)$

17. (a)
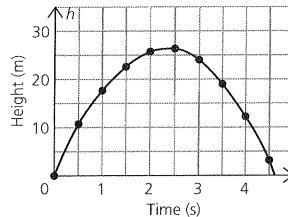
    (b) $x = 0$ or $x = 4.6$ (c) $y = -5x(x - 4.6)$

    (d) 26.45 m

18. (a)
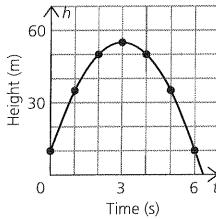
    $x = -0.1$ or $x = 6.1$

 $y = -5.8(x - 6.1)(x + 0.1)$

    10 m

    (b) 54.3 m after 2.5 s, 54.3 m after 3.5 s

    (c) after 3 s   (d) after 6.1 s

19. (a) $2997.56   (b) 547   (c) $5.48

20. (a) $y = -0.0012(x + 250)(x - 50)$

    (b) cost of making the vehicles

21. (a) Create an equation in factored form from each zero valued, then substitute the values from the point into the equation and solve for the resulting unknown quantity a.

    (b) the zeros

    (c) anything multiplied by 0 gives 0; so at least one of the factors must be 0

22. (a) (4)   (b) (1)

    (c) (2)   (d) (5)

23. (a)

2.5	3	3.5	4	4.5	5	5.06
32.125	30.9	27.225	21.1	12.525	1.5	0

    (b) $y = -4.9t^2 + 24.5t + 1.5$

    (c) 23.844 m

    (d) 32.125

Practise 3.5, page 288

1. (a) $(x + 2)(x + 1) = x^2 + 3x + 2$
   (b) $(x - 2)(x + 1) = x^2 - x - 2$
   (c) $(x + 2)(x - 2) = x^2 - 4$
   (d) $(2x + 2)(x + 2) = 2x^2 + 6x + 4$
2. (a) $x^2 + 5x + 6$ (b) $2x^2 + 7x + 6$
   (c) $x^2 - x - 6$ (d) $2x^2 - 8x + 6$
3. Because you "distributed" each term of one binomial by multiplying it by each of the terms in the second term. Then distributing the second term
5. (a) $x^2 + 7x + 12$ (b) $2x^2 + 5x + 2$
   (c) $6x^2 + 5x + 1$ (d) $x^2 + x - 2$
   (e) $2x^2 - 5x + 3$ (f) $6x^2 + x - 1$

Practise 3.6, page 291

(a) $y = x^2$ (b) $y = 3x^2 - 4$
(c) $y = -x^2 + 5x - 6$
(d) $y = -0.4621x^2 + 1839.1652x - 1829699.7454$

Practise, Apply, Solve 3.7, page 297

1. (a) m^2, 6   (b) k^2, k
   (c) $4r$, -12 (d) $-5x$, $-2x$
   (e) $6n^2$, $-4n$ (f) $-15m$, 6
2. (a) $d^2 + 3d + 2$ (b) $h^2 + h - 6$
   (c) $p^2 + p - 12$ (d) $a^2 - 5a + 6$
   (e) $w^2 - 6w + 9$ (f) $t^2 + 8t + 16$
3. (a) $2n^2 + 7n + 3$ (b) $3q^2 - 5q - 2$
   (c) $6x^2 - x - 1$ (d) $10m^2 + 13m - 3$
   (e) $4r^2 + 12r + 9$ (f) $16m^2 - 4$
   (g) $2a^2 + 4a - 30$ (h) $-2m^2 + 14m - 24$
   (i) $140h^2 + 15h - 90$ (j) $-42 + 148f - 96f^2$
   (k) $45h^2 + 3hk - 6k^2$ (l) $120x^2 + 42x - 36$
4. (a) $x^2 + 6x + 9$ (b) $x^2 - 14x + 49$
   (c) $x^2 + 16x + 64$ (d) $4x^2 + 4x + 1$
   (e) $16x^2 - 24x + 9$ (f) $25x^2 + 70x + 49$
5. (a) 2   (b) 2
   (c) $(x - 4)$ (d) $(x - 6)$ (e) $(x - 3)$
   (f) x, $5x$ (g) $6x$, x (h) $6x$, x
   (i) $(2y + 3)$ (j) $(2y + 3)$ (k) $(3x - 5)$
   (l) $(5x + 1)$
6. (a) $5 + 3 = 8$ but $(5)(3) \neq 10$
   (b) $-2 + 8 = 6$ but $(-2)(8) \neq -8$
   (c) $(2c)(3c) = 6c^2$ but $5(3c) + 3(2c) \neq 19c$
   (d) $(-5)(-3) = 15$
   but $(-5)(5d) + (2d)(-3) \neq -19d$
7. (a) $8m^2 + 4m - 12$
   (b) $9m^2 + 12m + 4$
8. (a) $y = -\frac{1}{3}x^2 + 2x$ (b) $y = -\frac{3}{4}x^2 + 6x - 9$
   (c) $y = \frac{5}{4}x^2 - 5$ (d) $y = \frac{4}{5}x^2 + \frac{28}{5}x + \frac{24}{5}$
9. (a) $m + 2$ (b) $x + 4$
10. (a) $y = -\frac{5}{16}(x - 3)^2 + 5$, down
    (b) $y = (x + 3)^2 - 4$, up
    (c) $y = \frac{1}{7}(x - 5)^2 - \frac{4}{7}$, up
    (d) $y = \frac{1}{7}(x - 2)^2 - \frac{16}{7}$, up

(e) $y = -\frac{7}{25}(x - 3)^2 + 7$, up

11. (b) $y = -5(x - 1)^2 + 5$
    (c) $y = -5x^2 + 10x$
    (d) The quadratic model is better for the data because the data represents a quadratic relationship.

12. (a)
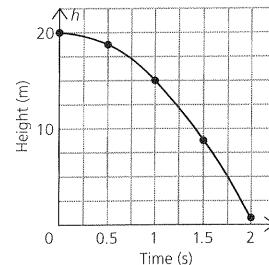
(b) after 2.1 s
(c) $x = -2.02$ and $x = 2.02$
(d) $y = -4.9x^2 + 20$
(e) $y = -4.89x^2 - 0.009x + 19.99$

13. $y = 0.000\,36x^2 + 4$
14. (a) $y = -x^2 + 10.5x + 2970$
    (b) \$5.25   (c) \$5.25
15. $y = -\frac{1}{48}x^2 + 192$
16. (a) expand and complete the square
    (b) factored form, because it gives the zeros and then you can find the vertex
    (c) discriminant is negative - there are no real roots
17. (a) $8x^2 + 11x - 3$ (b) $2x^2 - 18$
    (c) $7x^2 - 15x + 10$ (d) $-22x^2 - 64x - 54$
    (e) $7x^2 + 52x - 77$ (f) $-8x^2 + 52x - 11$
18. (a) $x^2 + 6x + 9$ (b) $4x^2 - 8x + 4$
    (c) $64x^3 + 96x^2y + 48xy^2 + 8y^3$
    (d) $x^4 - 8x^2 + 16$
    (e) $x^4 - 45x^2 + 324$
    (f) $9x^4 + 36x^3 + 30x^2 - 12x + 1$
    (g) $x^4 - 4x^3 + 6x^2 - 4x + 1$

Practise, Apply, Solve 3.8, page 307

1. (a) 7, 8   (b) -8, 2
   (c) -4, 3   (d) -5, 7
2. (a) $(x + 1)(x + 2)$ (b) $(x + 4)(x + 1)$
   (c) $(f - 3)^2$ (d) $(c - 3)(c + 5)$
   (e) $(g - 3)(g + 6)$ (f) $(r + 2)(r - 4)$
   (g) $(m - 7)(m + 2)$ (h) $(n - 4)(n - 5)$
   (i) $(x - 2)(x - 8)$ (j) $(a + 3)^2$
   (k) $(x - 3)(x - 5)$ (l) $(y + 4)^2$
   (m) $(x - 4)(x + 9)$ (n) $(b - 8)(b + 4)$
   (o) $(x - 7)(x - 8)$ (p) $(v - 3)(v + 9)$
   (q) $(t - 6)(t + 8)$ (r) $(p - 8)(p - 9)$
3. (a) $3(x + 3)(x + 5)$ (b) $2(y - 6)(y + 5)$
   (c) $3(a + 1)(a + 2)$ (d) $5(x - 1)^2$
   (e) $6(x + 5)(x - 1)$ (f) $x(x + 4)(x + 1)$
   (g) $8(m - 6)(m - 7)$ (h) $21(x + 2)(x - 1)$
   (i) $7(x + 7)(x - 3)$

4. (a) $(x + 5)(x - 5)$ **(b)** $(c + 7)(c - 7)$
   (c) $(a + 6)(a - 6)$ **(d)** $(x + 9)(x - 9)$
   (e) $(d + 11)(d - 11)$ **(f)** $(b + 8)(b - 8)$
   (g) $(3x + 2)(3x - 2)$ **(h)** $(8a + 1)(8a - 1)$
   (i) $(5p + 7)(5p - 7)$ **(j)** $(4c + 9)(4c - 9)$
   (k) $2(5r + 6)(5r - 6)$ **(l)** $7(y + 2)(y - 2)$

5. (a) $(3x - 1)^2$ **(b)** $(5x + 2)^2$ **(c)** $(2a - 5)^2$
   (d) $(7c + 3)^2$ **(e)** $(10x - 9)^2$ **(f)** $(6g + 5)^2$
   (g) $(3v - 2)^2$ **(h)** $(8c + 1)^2$ **(i)** $(4d - 3)^2$

6. (a) $(2t - 3)(t + 2)$ **(b)** $(3m + 1)(m - 4)$
   (c) $(5x - 1)(2x + 1)$ **(d)** $(3x + 2)^2$
   (e) $(3x - 2)^2$ **(f)** $(2x - 5)(2x - 3)$
   (g) $(2y + 1)(y + 1)$ **(h)** $(3b + 1)(b - 2)$
   (i) $(2c - 3)(c + 4)$ **(j)** $(3x + 1)(2x + 1)$
   (k) $(5a - 1)(a - 2)$ **(l)** $(3m + 2)(2m - 5)$
   (m) $(2d + 1)(d + 2)$ **(n)** $(3w - 2)(2w - 3)$
   (o) $(5b + 3)(2b - 1)$

7. (a) $3a(a + 2)$ **(b)** $2x(1 - 4y)$
   (c) $(5a + 3)(5a - 3)$ **(d)** $(x + 3)(x + 4)$
   (e) $(y - 4)(y - 7)$ **(f)** $(4a - 1)^2$
   (g) $(x + 2)(x + 4)$ **(h)** $(5b - 4)(b - 2)$
   (i) $2(5x - 4)(x - 2)$ **(j)** $3(d + 12)(d - 12)$
   (k) $(3d + 1)(2d + 1)$ **(l)** $(8c - 1)(7c + 2)$
   (m) $2(g - 4)(g + 3)$ **(n)** $(3x - 4)(3x + 4)$
   (o) $xy^2(xyz - 2)$

8. (a) $y = (x + 2)(x - 2)$; $-2, 2$; $(0, -4)$
   (b) $y = (x + 2)(x + 4)$; $-2, -4$; $(-3, -1)$
   (c) $y = (x - 5)(x - 1)$; $5, 1$; $(3, -4)$
   (d) $y = -(x - 6)(x + 4)$; $6, -4$; $(1, 25)$
   (e) $y = (x + 1)^2$; -1; $(-1, 0)$
   (f) $y = -(x - 6)(x + 3)$; $6, -3$; $(1.5, 20.25)$

9. 162 m^2

10. No, only those which cross the x-axis can be.

11. (a) after 6 s   **(b)** 45 m

12. (a) 30 m   **(b)** after 3 s
   (c) after 0.5 s   **(d)** 31.25 m

13. (a) $81\ 000   **(b)** 1000
   (c) 0 snowboards or 2000 snowboards sold

14. (a) $8\ 000\ 000   **(b)** 700 000
   (c) 500 000 or 900 000 games produced

15. (a) factor it or graph to obtain the roots, and can then find the vertex quickly
   (b) you know the x-intercepts (zeros)

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

17. (a) cannot factor
   (b) cannot factor
   (c) $2(2x + 5)(2x - 5)$
   (d) $\left(\dfrac{a}{8} + \dfrac{b}{7}\right)\left(\dfrac{a}{8} - \dfrac{b}{7}\right)$
   (e) $\left(\dfrac{c^2}{4} + \dfrac{d^2}{4}\right)\left(\dfrac{c}{2} + \dfrac{d}{3}\right)\left(\dfrac{c}{2} - \dfrac{d}{3}\right)$
   (f) $(25m^4n^2 + 4p^4)(5m^2n + 2p^2)(5m^2n - 2p^2)$
   (g) $(6 + w)(14 - w)$
   (h) *cannot factor in R*
   (i) $(x - y + 3z)(x - y - 3z)$
   (j) $(a + 3 + b)(a + 3 - b)$

   (k) $(2ab + 3c)^2$
   (l) $(3x - 1 + 2y)(3x - 1 - 2y)$

18. Yes, it was effective, because with the new equation, Soundz starts making a profit with fewer CD players made, and makes more profit that would be made earlier.

Practise, Apply, Solve 3.9, page 315

1. (a) $x = 2\ or\ x = -5$ **(b)** $y = 0\ or\ y = 5$
   (c) $m = -\dfrac{1}{2}\ or\ m = 3$ **(d)** $t = \dfrac{2}{3}\ or\ t = -3$
   (e) $x = \dfrac{1}{2}\ or\ x = \dfrac{2}{3}$ **(f)** $r = 3\ or\ r = -2$
   (g) $a = 0\ or\ a = 5$ **(h)** $x = -\dfrac{3}{4}\ or\ x = \dfrac{2}{5}$
   (i) $p = \dfrac{3}{4}\ or\ p = \dfrac{2}{7}$

2. (a) $n = -10\ or\ n = 3$ **(b)** $y = -4\ or\ y = -\dfrac{1}{2}$
   (c) $m = -5\ or\ m = -3$
   (d) $y = 3\ or\ y = -2$ **(e)** $x = 5\ or\ x = -3$
   (f) $m = 1\ or\ m = -1$ **(g)** $n = \dfrac{1}{2}\ or\ n = -\dfrac{1}{2}$
   (h) $x = \dfrac{5}{4}\ or\ x = -\dfrac{5}{4}$ **(i)** $n = \dfrac{1}{3}$
   (j) $x = -5\ or\ x = 2$ **(k)** $x = -3\ or\ x = -2$
   (l) $x = -\dfrac{1}{2}\ or\ x = 4$

3. (a) $x = 7\ or\ x = -6$ **(b)** $x = 7\ or\ x = -3$
   (c) $a = 8\ or\ a = -6$ **(d)** $m = -10\ or\ m = 3$
   (e) $x = \dfrac{3}{2}\ or\ x = -\dfrac{1}{3}$ **(f)** $x = 3\ or\ x = -\dfrac{5}{2}$
   (g) $y = -\dfrac{1}{2}\ or\ y = -4$ **(h)** $x = -\dfrac{2}{5}\ or\ x = -3$
   (i) $m = \dfrac{1}{2}\ or\ m = -3$

4. 4 m $\times$ 28 m or 14 m $\times$ 8 m

5. (a) $x = 1\ or\ x = -1$ **(b)** $x = 3\ or\ x = 2$
   (c) $x = 3\ or\ x = -\dfrac{7}{2}$

6. (a) $3, -2$ **(b)** $6, -3$
   (c) $5, 2$ **(d)** none
   (e) $3, -\dfrac{17}{6}$ **(f)** $6, 2$

8. (a) 500 m   **(b)** 30 s   **(c)** 3 s

9. (a) 1.5 s   **(b)** 2.1 s
   (c) The velocity is increasing.

10. 5 m

11. It will be reduced to 4.27 m.

12. (a) 188 000   **(b)** 68 000   **(c)** 1963 or 1992
   (d) no (the parabola does not intersect the x-axis)

13. (a) 15 m   **(b)** 4.8 s
   (c) 5.2 s   **(d)** 41.45 m

14. 92.5 m

15. (a) 6.816 m   **(b)** 45 km/h

16. 17.09 m

17. 12 m by 9 m

18. 20.48 m by 20.48 m

19. (a) substitute for y in the equation; solve by factoring if possible, after rearranging in $ax^2 + bx + c = 0$ form. Graph the new relation and solve graphically.

(b) 2; in a distance-time graph, a zero corresponding to a negative time value would not be reasonable.

20. Earth: $h = 2.3 + 50t - 4.9t^2$, 129.85 m, 10.2 s, 1.5 s; Mercury: $h = 2.3 + 50t - 1.862t^2$, 337.96 m, 26.9 s, 3.9 s; Venus: $h = 2.3 + 50t - 3.969t^2$, 159.77 m, 12.6 s, 1.8 s; Mars: $h = 2.3 + 50t - 1.96t^2$, 321.18 m, 25.6 s, 3.7 s; Jupiter: $h = 2.3 + 50t - 12.446t^2$, 52.52 m, 4.1 s, 0.6 s; Saturn: $h = 2.3 + 50t - 5.292t^2$, 120.40 m, 9.5 s, 1.4 s; Uranus: $h = 2.3 + 50t - 4.459t^2$, 142.47 m, 11.3 s, 1.6 s; Neptune: $h = 2.3 + 50t - 9.31t^2$, 69.43 m, 5.4 s, 0.8 s; Pluto: $h = 2.3 + 50t - 0.392t^2$, 1596.69 m, 127.6 s, 18.6 s; different masses and different densities

21. 10.67 m apart

Chapter 3 Review, page 323

1. (a) linear　　**(b)** cubic　　**(c)** exponential
(d) linear　　**(e)** linear
2. (a) $N_6 = 156$, $N_7 = 210$, $N_8 = 272$
(b) $N_n = 4n^2 + 2n$
3. (a) (d)
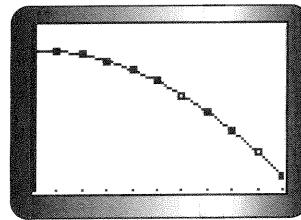
(b) quadratic
(c) $y = -5x^2 + 1200$
(e) about 15.5 s
4. (a) $x = -7$　**(b)** $x = 3.1$　**(c)** $x = -1$
(d) $x = -\frac{1}{8}$　**(e)** $x = \frac{79}{16}$　**(f)** $x = \frac{3}{4}$
5. (a) maximum　　　　**(b)** $x = \frac{3}{2}$
(c) positive (it is a maximum)
6. (a) $w = 0$ or $w = 18$, $w = 9$, maximum, $(9, 81)$
(b) $L = 0$ or $L = 10$, $L = 5$, maximum, $(5, 25)$
(c) $x = 0$ or $x = \frac{1}{4}$, $x = \frac{1}{8}$, maximum, $\left(\frac{1}{8}, \frac{1}{4}\right)$
(d) $t = 0$ or $t = 5$, $t = \frac{5}{2}$, maximum, $\left(\frac{5}{2}, \frac{125}{4}\right)$
(e) $x = 0$ or $x = -\frac{5}{2}$, $x = -\frac{5}{4}$, minimum, $\left(\frac{-5}{4}, \frac{-75}{8}\right)$
(f) $w = 0$ or $w = 7$, $w = \frac{7}{2}$, maximum, $\left(\frac{7}{2}, \frac{147}{2}\right)$
7. (a) $y = \frac{1}{2}(x - 1)(x + 3)$
(b) $y = \frac{-1}{4}(x - 20)(x - 60)$
(c) $y = \frac{1}{270}(x - 180)(x - 0)$
(d) $y = \frac{-2}{21}(x - 21)(x + 21)$
8. (a) $x = -3$ or $x = 1$, $x = 20$ or $x = 60$, $x = 0$ or $x = 180$, $x = -21$ or $x = 21$
**(b)** $-1, 40, 90, 0$

9. (a) $y = \frac{1}{2}(x - 5)(x - 9)$
(b) $y = -\frac{4}{25}(x + 3)(x - 7)$
(c) $y = \frac{3}{4}(x + 6)(x - 2)$
(d) $y = \frac{8}{45}(x + 9)(x + 5)$
10. (a) \$2
(b) Answers may vary. (eg cost of owning/operating a car)
(c) Answers may vary.
11. (a) $x^2 + 9x + 20$　　**(b)** $x^2 - 7x + 10$
(c) $x^2 - x - 42$　　**(d)** $4x^2 - 9$
(e) $12x^2 + 7x - 10$　**(f)** $30x^2 + 32x - 14$
(g) $30 - 8x - 6x^2$　**(h)** $20a^2 + 2ab - 6b^2$
(i) $4m^2 + 12mn + 9n^2$　**(j)** $-6x^2 - 21x + 12$
(k) $30u^2 - 55uv - 50v^2$　**(l)** $12x^2 - 14x - 40$
12. (a) $y = -x^2 + 2x + 3$
(b) $y = 2.5x^2 + 37.5x + 135$
(c) $y = 0.01x^2 + 1.6x - 15.36$
(d) $y = -\frac{11}{24}(x^2 - 49)$
13. (a) $y = -\frac{4}{3}x^2 + \frac{8}{3}x + \frac{32}{3}$
(b) $y = -\frac{1}{2}x^2 + 2x + 16$
14. (a) $(x + 5)(x - 3)$　　**(b)** $(m + 4)(m - 1)$
(c) $(r - 2)^2$　　　　**(d)** $(q - 5)(q + 2)$
(e) $(x + 1)(6x - 1)$　**(f)** $(2d + 1)(3d - 2)$
(g) $(x + 3)(x - 3)$　**(h)** $(2x + 5)(2x - 5)$
(i) $(3x + 2)^2$　　　**(j)** $3(m + 3)(m - 2)$
(k) $2(2p - 1)(2p + 3)$　**(l)** $3(3x + 4)(3x - 4)$
15. (a) $b = 5$ or $b = 2$　**(b)** 3500
16. (a) $x = 6$ or $x = -5$　**(b)** $x = 8$ or $x = -4$
(c) $x = -7$ or $x = -5$　**(d)** $x = -7$ or $x = 3$
(e) $x = -9$ or $x = 4$　**(f)** $x = 5$
(g) $x = \frac{2}{3}$ or $x = \frac{1}{2}$　**(h)** $x = \frac{1}{3}$ or $x = -\frac{4}{3}$
(i) $x = 7$ or $x = 6$
17. (a) $x = 5$ or $x = -6$　**(b)** $x = -4$ or $x = -3$
**(c)** $x = -1$ or $x = \frac{3}{2}$　**(d)** $x = \frac{3}{2}$ or $x = \frac{2}{3}$
18. (a)

(b)

(c)

(d)

19. (a) 65 m   **(b)** 3 s   **(c)** 4.74 s

20. (a) 1 m   **(b)** 2.8 m

Chapter 3 Review Test, page 337
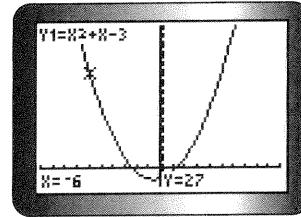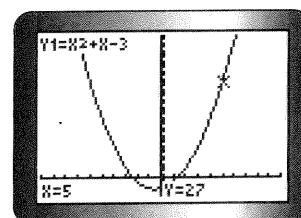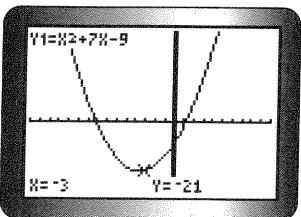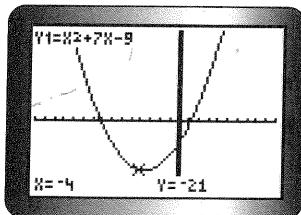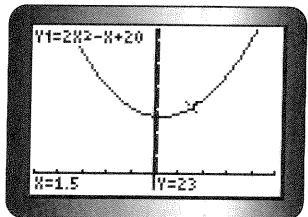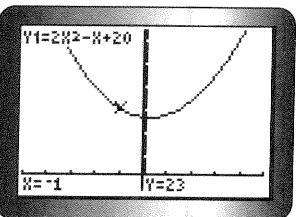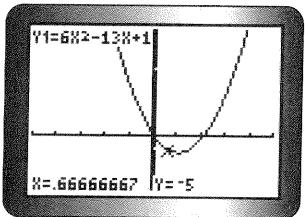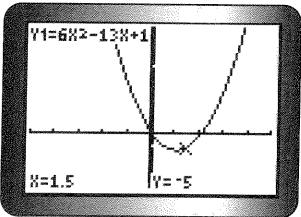
1. **(a)** quadratic   **(b)** neither
   (c) linear   **(d)** neither
2. **(a)** minimum   **(b)** $x = 3$
   (c) negative
3. **(a)** $x = 5$ **(b)** $x = -9$ or $x = 19$
   (c) $\frac{1}{7}x^2 - \frac{10}{7}x - \frac{171}{7}$
4. **(a)**
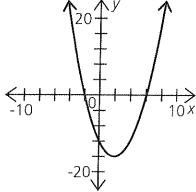
   (b)
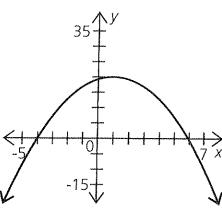
5. **(a)** $10x^2 - 11x - 6$ **(b)** $15a^2 - 14ab - 8b^2$
   (c) $-10x^2 + 25x + 210$
6. **(a)** $(x - 7)(x - 2)$ **(b)** $(4x + 5)(4x - 5)$
   (c) $(3x + 4)(2x - 1)$ **(d)** $2(x + 3)(x + 2)$
7. **(a)** $x = 3$ or $x = -7$ **(b)** $x = -2$ or $x = -6$
   (c) $x = \frac{1}{3}$ or $x = -\frac{5}{2}$
8. **(a)** The second difference from 3 to 8 is constant.
   (b) $y = -4.87x^2 + 37.46x + 13.55$
   (c) 16 m, after 3.8 s, 85.58, 8 s
   (d) $y = -4.87x^2 + 37.46x + 13.55$
9. **(a)** 3000   **(b)** 7600
   (c) 2556   **(d)** 2061
   (e) The function is always increasing.
10. $8

Chapter 4

Getting Ready, page 340

1. **(a)** yes   **(b)** no   **(c)** yes
2. It allows you to find the x-intercepts or zeros.
3. **(a)** 3   **(b)** 3
   (c) 5.5   **(d)** 3.05
   (e) $-1.91\overline{6}$ **(f)** -7
4. **(a)** $y = x^2 + 9x + 20$ **(b)** $y = 2x^2 + x - 6$
   (c) $y = -3x^2 - 9x + 84$ **(d)** $y = x^2 + 10x + 25$
   (e) $y = -5x^2 + 5x$ **(f)** $y = 2x^2 + 12x + 12$
5. **(a)** linear   **(b)** quadratic
   (c) quadratic   **(d)** linear
   (e) neither   **(f)** quadratic