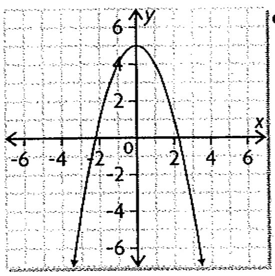
10. a) The graph for the bedsheet will be the narrowest parabola. The graph for the car tarp will be wider than the graph for the bedsheet. The graph for the parachute will be the widest parabola of all three. An object dropped from 100 m will hit the ground at about 4.5 s with a bedsheet, at about 5 s with a car tarp, and at about 15 s with a regular parachute.

b) Yes. If the object with the bedsheet is dropped from a much higher altitude than the object with the parachute is dropped, or at an earlier time, it is possible for them to hit the ground at the same time. The graph for the bedsheet would be narrower than the graph for the parachute, and it would have a much higher vertex. The positive zeros would be equal.

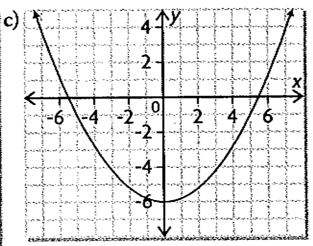
11. a) $y = -x^2 + 5$ c) $y = \frac{1}{5}x^2 - 6$

b) $y = 5(x + 2)^2$ d) $y = -6(x - 3)^2 + 4$

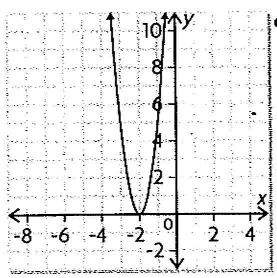
12. a)



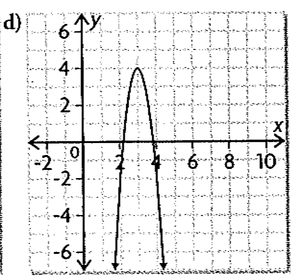
c)



b)



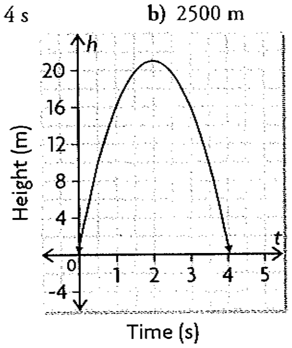
d)



13. The equation in part c) is $y = -\frac{2}{3}(x - 3)^2 + 5$. The vertex is at (3, 5), so the equation is of the form $y = a(x - 3)^2 + 5$. The parabola opens downward, so a is negative. Substituting for point (0, −1) in the equation gives $-1 = a(-3)^2 + 5$. Solving for a gives $a = -\frac{2}{3}$.

14. a) 4 s b) 2500 m

15. a)



b) 21 m

c) 2 s

d) about 0.5 s and 3.5 s

e) about 4 s

16. Answers may vary, e.g., translation 5 units right and 8 units up: $y = (x - 5)^2 + 8$; reflection in the x-axis, translation 5 units right and 26 units up: $y = -(x - 5)^2 + 26$; vertical stretch by a factor of $\frac{17}{9}$ and shift 5 units right: $y = \frac{17}{9}(x - 5)^2$.

17. standard form: $y = 2x^2 + 12x - 80$;
vertex form: $y = 2(x + 3)^2 - 98$

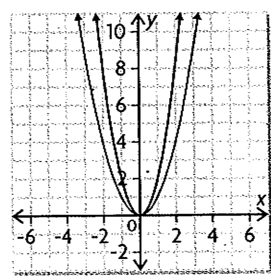
18. Answers may vary, e.g.,

Translation: 3 units left, 4 units up		Reflection: reflected in the x-axis
	$y = -2(x + 3)^2 + 4$	
Stretch/Compression: stretch by a factor of 2		Vertex: (−3, 4)

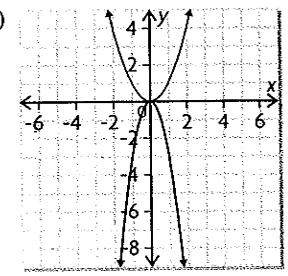
19. zero: $k - 1$ or 1

Mid-Chapter Review, page 274

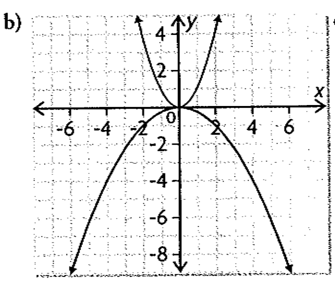
1. a)



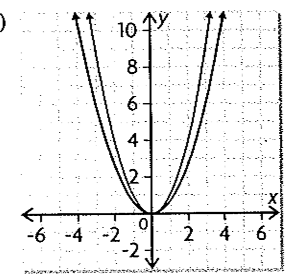
c)



b)



d)

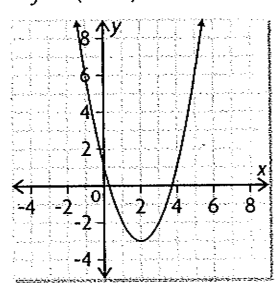


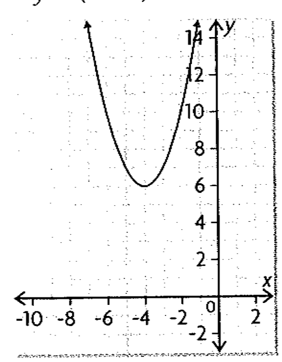
2. a) vertical stretch by a factor of 4; $y = 4x^2$

b) reflection in the x-axis; $y = -x^2$

3. a) $h = 2, k = -3$;
$y = (x - 2)^2 - 3$

b) $h = -4, k = 6$;
$y = (x + 4)^2 + 6$

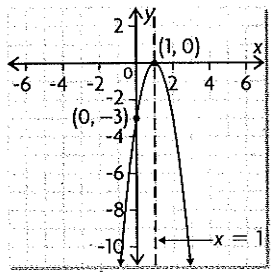




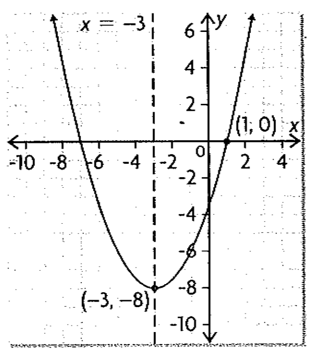
4. Answers may vary, e.g., $y = (x + 3)^2 - 3$, $y = (x + 2)^2 - 2$, $y = (x + 1)^2 - 1$, $y = x^2$, $y = (x - 1)^2 + 1$, $y = (x - 2)^2 + 2$, $y = (x - 3)^2 + 3$

5. a) vertical stretch by a factor of 3, reflection in the x-axis, translation 1 unit right
   b) vertical compression by a factor of 0.5, translation 3 units left and 8 units down
   c) vertical stretch by a factor of 4, translation 2 units right and 5 units down
   d) vertical compression by a factor of $\frac{2}{3}$, translation 1 unit down

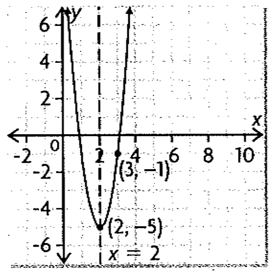
6. a) Answers may vary for points labelled, e.g.,



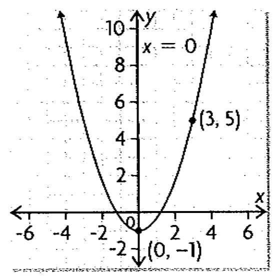
b) Answers may vary for points labelled, e.g.,



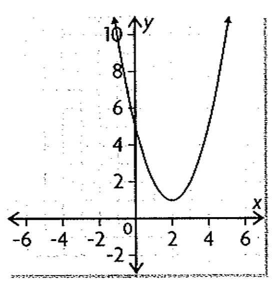
c) Answers may vary for points labelled, e.g.,



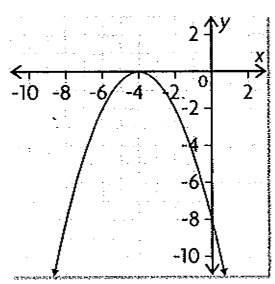
d) Answers may vary for points labelled, e.g.,



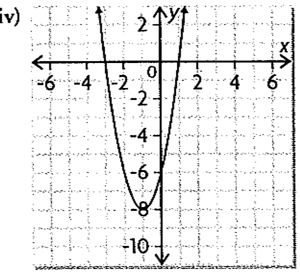
7. a) i) stretch by a factor of 1, translation 2 units right and 1 unit up
   ii) no reflection
   iii) (2, 1), $x = 2$
   iv)



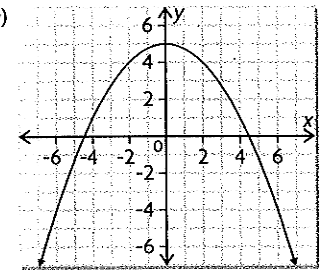
b) i) compression by a factor of 0.5, translation 4 units left
   ii) reflection
   iii) $(-4, 0)$, $x = -4$
   iv)



c) i) stretch by a factor of 2, translation 1 unit left and 8 units down
   ii) no reflection
   iii) $(-1, -8)$, $x = -1$
   iv)



d) i) compression by a factor of 0.25, translation 5 units up
   ii) reflection
   iii) (0, 5), $x = 0$
   iv)

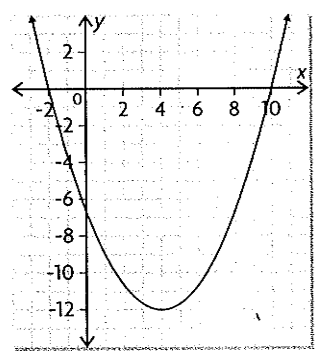


8. If $a > 0$, then $k > 0$; the vertex is above the x-axis and opens upward. Answers may vary, e.g., $y = 3x^2 + 2$
If $a < 0$, then $k < 0$; the vertex is below the x-axis and opens downward. Answers may vary, e.g., $y = -3x^2 - 2$

Lesson 5.4, page 280

1. a) iii b) iv c) i d) ii

2. a) $y = a(x - 4)^2 - 12, a \neq 0$
   b) $a = \frac{1}{3}$
   c) $y = \frac{1}{3}(x - 4)^2 - 12$
   d) vertical compression by a factor of $\frac{1}{3}$, translation 4 units right and 12 units down
   e)



3. a) $y = 0.25x^2$
   b) $y = 2(x + 1)^2$
   c) $y = -x^2 + 4$
   d) $y = -(x - 1)^2 + 2$
   e) $y = -3(x - 2)^2 + 4$
   f) $y = 5(x + 2)^2 - 3$

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

5. a) $y = x^2 + 4$
   b) $y = -(x - 5)^2$
   c) Answers may vary, e.g., $y = 2(x - 2)^2 - 3$
   d) Answers may vary, e.g., $y = -0.5(x + 3)^2 + 5$
   e) Answers may vary, e.g., $y = 2(x - 4)^2 - 8$
   f) Answers may vary, e.g., $y = -0.5(x - 3)^2 - 4$

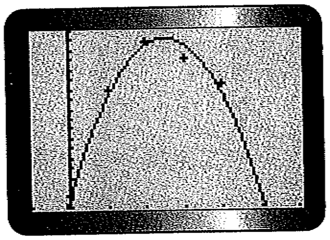
Answers

6. a) $y = -0.5(x + 2)^2 + 3$
b) $y = 2(x + 1)^2 - 1$
c) $y = (x + 2)^2 - 3$
d) $y = -(x + 2)^2 + 5$

7. a) $x = 5, y = -4(x - 5)^2 + 3$
b) $x = 1.5, y = 4(x - 1.5)^2 + 3$

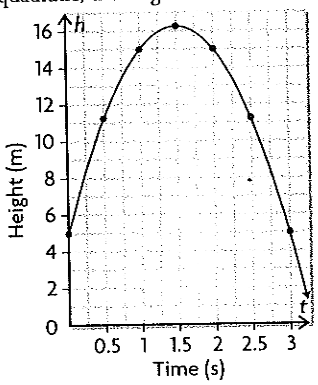
8. Answers may vary, e.g., $y = -\frac{2}{9}(x - 3)^2 + 2$

9. a)



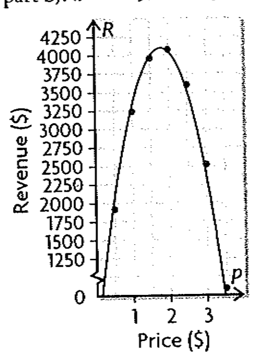
b) Answers may vary, e.g., vertex: about (2.5, 4625); $y = -509(x - 2.5)^2 + 4625$
c) Zero DVDs were sold. This shows limits of making predictions into the future. The prediction assumes that the decreasing trend in sales continues indefinitely, which may or may not be the case.
d) regression: $y = -484x^2 + 2440x + 1553$; standard form of relation in part b): $y = -509x^2 + 2545x + 1443.75$; reasonably accurate

10. a) quadratic; the height values increase and then decrease.
b)



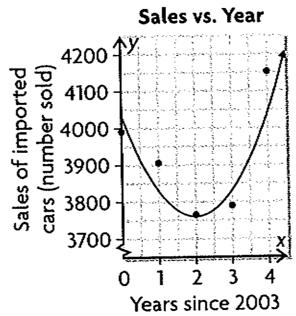
c) Answers may vary, e.g., about (1.5, 16.25)
d) $h = -5(t - 1.5)^2 + 16.25$
e) 8.4375 m, 15.9375 m
f) not effective; the height is negative, which would mean that the ball is under ground level.
g) regression: $h = -5t^2 + 15t + 5$; standard form of relation in part b): $h = -5t^2 + 15t + 5$; highly accurate

11. a)



b) Answers may vary, e.g., $R = -1200(p - 1.8)^2 + 4100$
c) Answers may vary, e.g., about $4000
d) Answers may vary, e.g., $1.80
e) regression: $R = -1200p^2 + 4440p$; standard form of relation in part b): $R = -1200p^2 + 4320p + 212$; reasonably accurate

12. a) Answers may vary, e.g., in this model, x is the number of years since 2003 and y is the number of imported cars sold.



b) Answers may vary, e.g., $y = 70(x - 2)^2 + 3760$
c) Answers may vary, e.g., about 4390
d) Answers may vary, e.g., about 3830. This is reasonably accurate since it is about 1.5% higher than the actual value.
e) regression: $y = 77x^2 - 288x + 4036$; standard form of relation in part b): $y = 70x^2 - 280x + 4040$; reasonably accurate

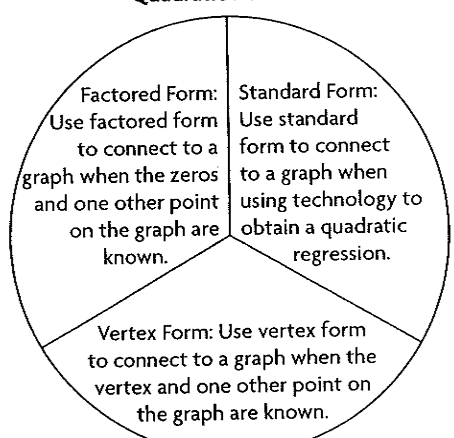
13. $h = 0.000\,083\,5(x - 758)^2 + 2$, where h represents the height of the cable from the road and x represents the horizontal distance from one of the towers

14. Strategy 1: The vertex is (20, 2000). Substitute (40, 0) in $h = a(t - 20)^2 + 2000$ to determine the value of a.
Strategy 2: The two zeros are (0, 0) and (40, 0). Substitute the vertex (20, 2000) in $h = at(t - 40)$ to determine the value of a.

15. $p = -0.6(d - 75)^2 + 1600$

16. Answers may vary, e.g.,

Quadratic Relations



17. a) $y = 2(x - 1)^2 - 1$
b) $y = -2(x + 3)^2 - 1$
c) $y = -2(x + 3)^2 - 4$
d) $y = 12(x + 3)^2 - 1$
e) $y = 0.5(x - 3)^2 - 6$

18. $b = 6, c = 7$

19. $x = h \pm \sqrt{-\frac{k}{a}}$

Lesson 5.5, page 293

1. a) $y = 2x^2 + 3$
b) $y = -3(x - 2)^2$
c) $y = -(x - 3)^2 - 2$
d) $y = 0.5(x + 3.5)^2 + 18.3$

2. a) minimum value: 3
b) maximum value: 0
c) maximum value: -2
d) minimum value: 18.3

3. a) $y = -0.0625x^2$
b) The value of a is the same in each of these equations since the parabolas are congruent.

4. a) $y = -2x^2 + 3$
b) $y = (x - 2)^2$
c) $y = 3(x + 3)^2 + 2$
d) $y = -\frac{5}{16}(x - 5)^2 - 3$

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

6. a) standard form: $y = x^2 + 2x - 3$;
factored form: $y = (x - 1)(x + 3)$
b) standard form: $y = 2x^2 - 16x + 30$;
factored form: $y = 2(x - 5)(x - 3)$
c) standard form: $y = -x^2 + 8x - 12$;
factored form: $y = -(x - 2)(x - 6)$
d) standard form: $y = -\frac{1}{2}x^2 + 4$;
factored form: $y = -\frac{1}{2}(x^2 - 8)$

7. $y = -0.5(x - 3)^2 + 12.5$

8. minimum value: -10; $y = 2(x - 1)^2 - 10$

9. a) standard form: $y = x^2 - 8x + 15$;
factored form: $y = (x - 5)(x - 3)$
b) standard form: $y = 2x^2 + 4x - 16$;
factored form: $y = 2(x + 4)(x - 2)$
c) standard form: $y = -x^2 - 10x - 24$;
factored form: $y = -(x + 4)(x + 6)$
d) standard form: $y = -3x^2 - 18x + 48$;
factored form: $y = -3(x + 8)(x - 2)$

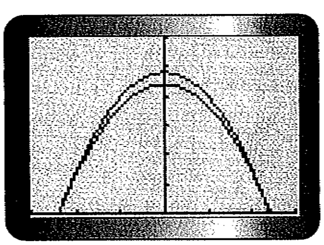
10. a) factored form: $y = 2x(x - 6)$;
vertex form: $y = 2(x - 3)^2 - 18$
b) factored form: $y = -2(x - 8)(x - 4)$;
vertex form: $y = -2(x - 6)^2 + 8$
c) factored form: $y = (2x + 3)(x - 2)$;
vertex form: $y = 2(x - 0.25)^2 - 6.125$
d) factored form: $y = (2x + 5)^2$;
vertex form: $y = 4(x + 2.5)^2$

11. \$5.00

12. translation 4 units right and 10 units up

13. a) 1997
b) \$5.09
c) \$14.81
d) $C = 0.06(t - 2.25)^2 + 5.056\,25$

14. Answers may vary, e.g., $y = -\frac{11}{72}x^2 + 22$; $y = -\frac{1}{6}x^2 + 24$



15. a) $P = -20(x - 2)^2 + 3380$
b) A ticket price of \$13 gives a maximum profit of \$3380; about 260 tickets sold.

16. No. Clearance 8 m from the axis of symmetry is only 26.928 m.

17. $(0, -4)$

18. Answers may vary, e.g., disagree. Vertex form is best for determining maximum and minimum values, because they equal the y-coordinate of the vertex. Factored form, or standard form with technology when the quadratic relation is not factorable, is best for determining zeros.

19. maximum value: 1

20. a) left: $y = -\frac{1}{5}x(x - 8)$; right: $y = -\frac{1}{5}(x - 2)(x - 10)$ b) 3.2 m

Lesson 5.6, page 301

1. $x = -2$

2. Answers may vary, e.g., (0.5, 0), (2.5, 0)

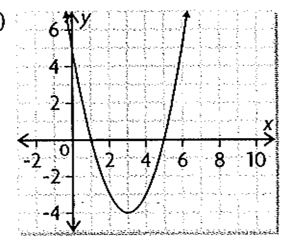
3. $y = 2(x - 2.5)^2 - 1.5$

4. a) $x = 5$
b) vertex: (5, 8); $y = -2(x - 5)^2 + 8$
c) $y = -2x^2 + 20x - 42$

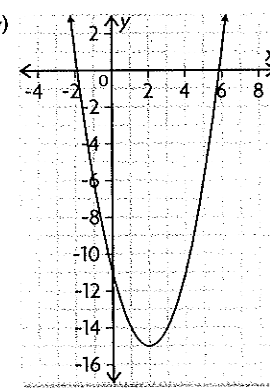
5. a) i) Answers may vary, e.g., (−7, 0), (1, 0)
ii) $x = -3$
iii) (−3, −16)
iv) $y = (x + 3)^2 - 16$
b) i) Answers may vary, e.g., (0, −8), (6, −8)
ii) $x = 3$
iii) (3, −17)
iv) $y = (x - 3)^2 - 17$
c) i) Answers may vary, e.g., (−3, 0), (7, 0)
ii) $x = 2$
iii) (2, 50)
iv) $y = -2(x - 2)^2 + 50$
d) i) (0, 2), (−4, 2)
ii) $x = -2$
iii) (−2, −10)
iv) $y = 3(x + 2)^2 - 10$
e) i) Answers may vary, e.g., (−5, 0), (0, 0)
ii) $x = -2.5$
iii) (−2.5, −6.25)
iv) $y = (x + 2.5)^2 - 6.25$
f) i) Answers may vary, e.g., (0, 21), (11, 21)
ii) $x = 5.5$
iii) (5.5, −9.25)
iv) $y = (x - 5.5)^2 - 9.25$

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

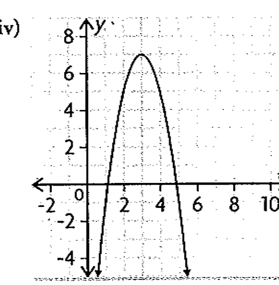
7. a) i) Answers may vary, e.g., (0, 5), (6, 5)
ii) (3, −4)
iii) $y = (x - 3)^2 - 4$
iv)



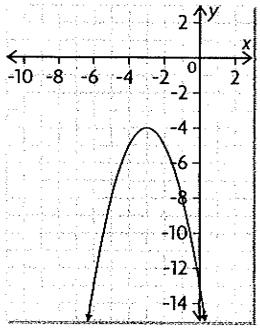
b) i) Answers may vary, e.g., (0, −11), (4, −11)
ii) (2, −15)
iii) $y = (x - 2)^2 - 15$
iv)

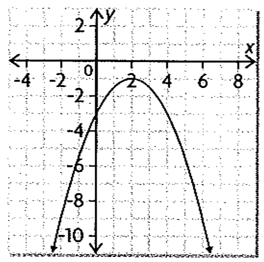


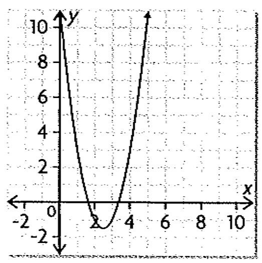
c) i) Answers may vary, e.g., (0, −11), (6, −11)
ii) (3, 7)
iii) $y = -2(x - 3)^2 + 7$
iv)



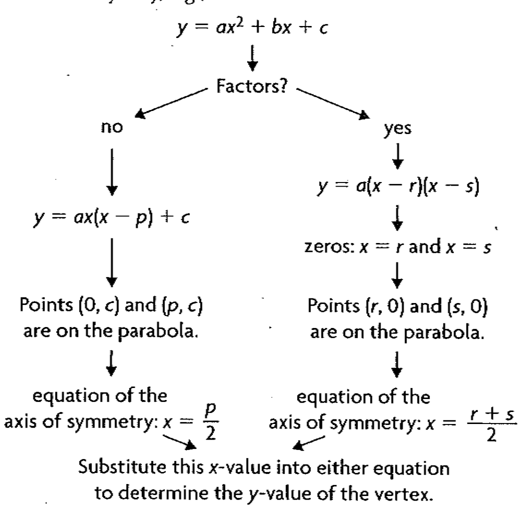
Answers

d) i) Answers may vary, e.g., $(0, -13)$, $(-6, -13)$
ii) $(-3, -4)$
iii) $y = -(x + 3)^2 - 4$
iv)


e) i) Answers may vary, e.g., $(0, -3)$, $(4, -3)$
ii) $(2, -1)$
iii) $y = -0.5(x - 2)^2 - 1$
iv)


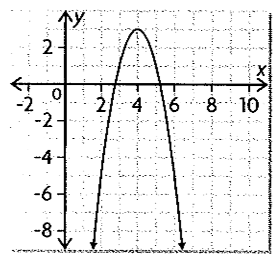
f) i) Answers may vary, e.g., $(0, 11)$, $(5, 11)$
ii) $(2.5, -1.5)$
iii) $y = 2(x - 2.5)^2 - 1.5$
iv)


8. Answers may vary, e.g., strategy 1: factor directly; strategy 2: use partial factoring to write the relation in vertex form; $x = 4$; writing the relation in vertex form requires less calculation.
9. $a = \frac{3}{4}$, $b = -6$
10. $a = 1$, $b = -2$
11. 1125 m
12. 5.05 m
13. $7.50
14. a) 1977 b) about 1215 t c) about 1522 t
15. Answers may vary, e.g.,

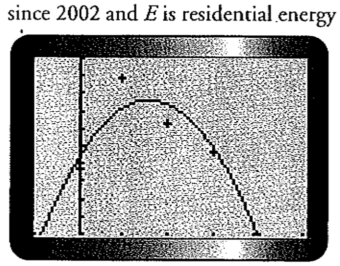


16. 15 000 m^2
17. $2.00; 1050

Chapter Review, page 304

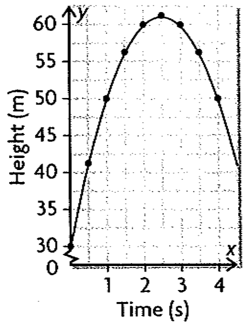
1. a) Answers may vary, e.g., $y = 4x^2$, $y = 10x^2$
b) Answers may vary, e.g., $y = 0.1x^2$, $y = -0.4x^2$
c) Answers may vary, e.g., $y = -6x^2$, $y = -10x^2$
2. Substitute the value of p into $y = x^2$. If the y-value is less than q, then the parabola is wider than $y = x^2$. If the y-value is greater than q, then the parabola is narrower than $y = x^2$.
3. a) ii b) iii c) iv d) i
4. d); vertical compression by a factor of 2, reflection in the x-axis, translation 3 units to the right and 8 units up; therefore, $a = -2$, $(h, k) = (3, 8)$
5. Same; Both include vertical stretches by a factor of 2. Different: One includes a translation 4 units right and 5 units up; the other includes a translation 5 units right and 4 units up.
6. $y = -(x - 6)^2 - 8$
7. a) He needed to stretch the graph vertically before translating it.
b) Start by reflecting the graph of $y = x^2$ in the x-axis. Then stretch the graph vertically by a factor of 2. Finally, translate the graph so that its vertex moves to $(4, 3)$.
c)


8. a) $y = \frac{2}{3}(x + 5)^2 + 1$
b) $y = 4(x + 1)^2 - 7$
c) $y = 2(x - 7)^2$
d) $y = \frac{1}{2}(x - 4)^2 + 5$
9. a) $y = \frac{1}{2}(x + 3)^2 + 2$
b) $y = -2(x - 1)^2 + 5$
10. a) Answers may vary, e.g., in this model, x is the number of years since 2002 and E is residential energy used.



b) Answers may vary, e.g., about $(1.57, 1326)$; $E = -13(x - 1.57)^2 + 1326$
c) about July 27, 2003

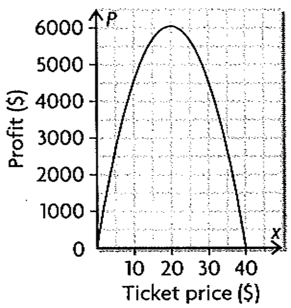
11. a)



b) Answers may vary, e.g., about (2.5, 61)
c) Answers may vary, e.g., $-5(x - 2.5)^2 + 61$
d) regression: $y = -5x^2 + 25x + 30$; standard form of relation in part c): $y = -5x^2 + 25x + 29.75$; very accurate

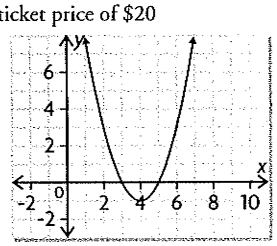
12. 1.4 kg/ha

13. a)

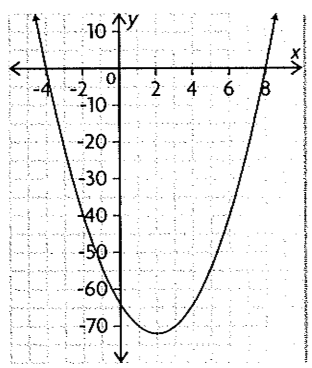


b) maximum profit of \$6050 at a ticket price of \$20

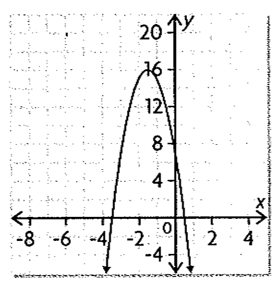
14. a) i) $y = (x - 3)(x - 5)$
ii) $(4, -1)$
iii) $y = (x - 4)^2 - 1$
iv)



b) i) $y = 2(x + 4)(x - 8)$
ii) $(2, -72)$
iii) $y = 2(x - 2)^2 - 72$
iv)



c) i) $y = -(2x + 7)(2x - 1)$
ii) $(-1.5, 16)$
iii) $y = -4(x + 1.5)^2 + 16$
iv)



15. a) Answers may vary, e.g., (0, 5), (−2, 5); $y = (x + 1)^2 + 4$
b) Answers may vary, e.g., (0, −3), (6, −3); $y = -(x - 3)^2 + 6$
c) Answers may vary, e.g., (0, −147), (14, −147); $y = -3(x - 7)^2$
d) Answers may vary, e.g., (0, 41), (10, 41); $y = 2(x - 5)^2 - 9$

16. a) $y = (x - 3)^2 - 17$
b) $y = -2(x - 2)^2 + 50$
c) $y = 3(x + 2)^2 - 10$
d) $y = -2(x - 3)^2 + 7$

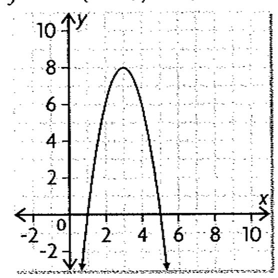
17. a) 1.1 m
b) maximum height: 27.0 m at time 2.3 s

Chapter Self-Test, page 306

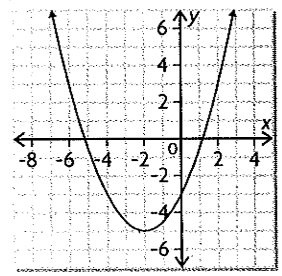
1. a) $y = \frac{1}{2}(x - 1)^2 - 9$
b) vertical compression by a factor of $\frac{1}{2}$, translation 1 unit right and 9 units down

2. a) $y = -4(x - 7)^2 + 5$
b) $y = 3(x - 3)^2 - 12$

3. a)



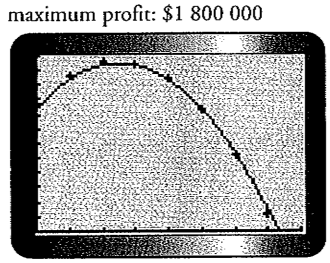
b)



4. Answers may vary, e.g., $y = 2(x - 4)^2 - 10$

5. a) $P = -2(x - 3)(x - 9)$
b) zeros: 3, 9; break-even values (in \$100 000s)
c) number of shoes sold: 600 000; maximum profit: \$1 800 000

6. a)



b) vertex: (2.5, 115); $h = -5(t - 2.5)^2 + 115$; $h = -5t^2 + 25t + 83.75$
c) regression: $h = -5t^2 + 24t + 88$; very close to model for part b)
d) maximum height: 116.8 m 2.4 s after it is launched
e) about 7.23 s

Chapter 6

Getting Started, page 310

1. vertex: $(-1, 8)$;
equation of the axis of symmetry: $x = -1$;
zeros: -3, 1'

2. a) iii b) i c) ii