20. Determine the value of k so that the graph of $y = (x + 3)^2 + k$ passes through the point (1, 20).

C

21. Write an equation for the parabola with the given vertex and passing through the given point.

a) vertex (−4, −5); point (−2, −1)
b) vertex (3, 2); point (1, −2)
c) vertex (1, 6); point (3, 2)
d) vertex (−2, 3); point (−1, 6)
e) vertex (−5, −3); point (−3, −11)
f) vertex (6, 4); point (8, 6)

22. Write an equation for each parabola, given the vertex and the y-intercept.

a) vertex (1, 2); y-intercept 4
b) vertex (−2, 3); y-intercept −1
c) vertex (2, −4); y-intercept −2
d) vertex (−4, −1); y-intercept −5

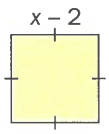
23. Find a and k so that the given points lie on the parabola.

a) $y = a(x - 1)^2 + k$; (2, 6), (3, 12)
b) $y = a(x + 3)^2 + k$; (−5, −8), (1, −20)
c) $y = a(x - 4)^2 + k$; (1, −13), (−1, −45)

24. Communication Describe the graph of $y = a(x - h)^2 + k$ if

a) $h = 0$ **b)** $k = 0$ **c)** $h = 0$ and $k = 0$

25. Geometry The area of a square is 3 square units greater than the area of the square shown.

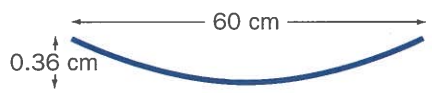


a) Write an equation that relates the area, A, of the larger square to the value of x.
b) Sketch a graph of A versus x for the larger square.
c) What value of x results in the minimum area for the larger square?
d) What is the area of the smaller square when the larger square has its minimum area?

26. Write the equation of the image of $y = 3(x - 2)^2 + 1$ that results from

a) a reflection in the x-axis
b) a reflection in the y-axis
c) a reflection in the y-axis, followed by a reflection in the x-axis

27. Astronomy British astronomer William Lassell used a telescope he built himself to discover a moon around Neptune in 1846, two moons around Uranus in 1851, and a moon around Saturn in 1858. The mirror from his telescope has a diameter of about 60 cm and a maximum depth of about 0.36 cm. A cross section of the mirror is in the shape of a parabola.



a) Suppose the origin of a coordinate grid is placed at the vertex, the y-axis is the axis of symmetry, and the units on the axes are centimetres. What are the coordinates of each end of the curve?
b) Write an equation for the curve.

Section 4.1 pp. 197–199

Practice **1. a)** function **b)** function **c)** not a function **d)** function **e)** function **f)** not a function **2. a)** 3 **b)** 23 **c)** −5 **d)** −13 **e)** −21 **f)** 395 **g)** −3 **h)** −7 **i)** 3995 **3. a)** 6 **b)** 2 **c)** −2 **d)** 14 **e)** 8 **f)** −12 **g)** 7 **h)** 8.2 **i)** 0 **4. a)** 9 **b)** 5 **c)** 9 **d)** 105 **e)** 105 **f)** 5.25 **g)** 5.01 **5. a)** 3 **b)** 1 **c)** 19 **d)** 163 **e)** 243 **f)** 1.5 **g)** 1.5 **6. b)** yes **7. a)** function **b)** not a function **c)** function **d)** not a function **8. a)** domain: {3, 4, 5, 6}, range: {−2, 0, 1, 3} **b)** domain: {−3, −1, 1, 3, 5}, range: {2, 3, 4} **c)** domain: {−2, −1, 0, 1}, range: {3, 4} **d)** domain: {−1}, range: {1, 2, 3, 4} **9. a)** domain: {−2, −1, 0, 1, 2}, range: {1, 2, 5}; function **b)** domain: {0, 1, 2, 3}, range: {−2, −1, 0, 1}; not a function **10. a)** domain: {−2, 0, 2, 4, 6}, range: {0, 2, 4, 6, 8} **b)** domain: set of real numbers, range: set of real numbers **c)** domain: set of real numbers, range: $y \leq 2$ **d)** domain: {1}, range: set of real numbers **11.** {2, 3, 6}

Applications and Problem Solving **12. a)** 2; 2.5 **b)** speed: independent, Mach number: dependent. The Mach number depends on the speed. **13. b)** 17.6 million **c)** 2039 **14. b)** No, the domain and range are both the set of real numbers. **c)** x does not have a minimum or maximum value. The domain is the set of real numbers. y has a minimum value of 0, but no maximum value. The range is the set of real numbers greater than 0. **15. a)** range: set of real numbers **b)** range: $y \geq -2$ **16. a)** ± 2 **b)** ± 4 **c)** 0 **d)** $\pm\sqrt{11}$ **17. a)** no **b)** Yes, there is only one name for every set of fingerprints. **18.** No, there are likely several people with the same first name. **19.** Since the x-coordinates of the points on a vertical line are all equal, if a vertical line passes through more than one point of the graph of a relation, then the relation contains two different points with the same x-coordinate, and so is not a function. **20. a)** $y = 8a + 3$ **b)** $y = -1 - 3n$ **c)** $y = m^2 - 2m + 2$ **d)** $y = 8k^2 + 8k - 1$ **e)** $y = 9t^2 + 6t - 4$ **f)** $y = 12w^2 - 32w + 25$ **21.** It is a vertical line. **22. a)** A closed dot is used to show the location of an ordered pair on a graph; an open dot is used to show that an ordered pair is omitted from the graph. **b)** It looks like steps. **c)** domain: $0 \leq t \leq 4$, range: {120, 200, 280, 360} **d)** (0.5, 120), (1, 120) **e)** (1, 120), (2, 200) **f)** No, the graph is a function.

Investigation pp. 200–203

1 Translations on a Coordinate Grid **1. a)** D′(2, 4), E′(−2, 4), F′(−2, −2) **b)** P′(−1, 4), Q′(−5, 6), R′(−7, −3) **c)** U′(−3, −4), V′(−1, 3), W′(0, 0) **d)** F′(4, −1), G′(−2, 6), H′(1, −2) **e)** A′(1, −3), B′(7, −4), C′(5, −7) **f)** J′(−1, −2), K′(−4, −1), L′(−6, −6) **2.** R(1, −4), S(−2, 3), T(−4, −5) **3. a)** A′(7, 3), B′(3, 8), C′(1, 4) **b)** A″(6, −2), B″(2, 3), C″(0, −1) **c)** 3 units to the right, 2 units downward

2 Reflections on a Coordinate Grid **1. a)** A′(2, −4), B′(1, −1), C′(6, −2) **b)** D′(0, −3), E′(5, −4), F′(2, 0) **c)** P′(1, −2), Q′(−3, 2), R′(3, 1) **2. a)** A′(−1, 3), B′(−2, 1), C′(−6, 3) **b)** D′(−1, 2), E′(0, −2), F′(−3, 1) **c)** P′(2, 1), Q′(3, −3), R′(−1, −2) **3. a)** (2, −3), (−2, 3) **b)** (−1, 2), (1, −2) **c)** (−3, −2), (3, 2) **d)** (4, 0), (−4, 0) **4.** A′(−1, 1), B′(−5, 2), C′(−3, 6) **5.** R′(2, −5), S′(−2, −4), T′(−1, 2) **6. a)** y-axis **b)** x-axis

3 Dilatations on a Coordinate Grid **1. a)** 2 **b)** $\frac{1}{3}$ **2. a)** A′(6, 4), B′(2, 8) **b)** C′(3, 2), D′(−1, 1) **c)** E′(−3, −3), F′(3, 6) **d)** G′(3, 1), H′(−2, 0) **3.** R′(6, 9), S′(−3, 12), T′(−9, −6) **4.** D′(3, 2), E′(−1, 3), F′(−2, −2), G′(2, −3) **5. b)** 8 **c)** P′(−6, 6), Q′(−6, −6), R′(6, −6) **d)** 72 **e)** P″(−1, 1), Q″(−1, −1), R″(1, −1) **f)** 2 **g)** 9:1; $\frac{1}{4}$:1 **h)** The first term is the square of the scale factor.

Section 4.2 pp. 213–216

Practice **1. a)** up; (0, 5); $x = 0$; domain: set of real numbers, range: $y \geq 5$; minimum: 5 **b)** up; (0, −2); $x = 0$; domain: set of real numbers, range: $y \geq -2$; minimum: −2 **c)** down; (0, −1); $x = 0$; domain: set of real numbers, range: $y \leq -1$; maximum: −1 **d)** down; (0, 4); $x = 0$; domain: set of real numbers, range: $y \leq 4$; maximum: 4 **e)** up; (0, 0); $x = 0$; domain: set of real numbers, range: $y \geq 0$; minimum: 0 **f)** down; (0, 0); $x = 0$; domain: set of real numbers, range: $y \leq 0$; maximum: 0 **g)** up; (0, −1); $x = 0$; domain: set of real numbers, range: $y \geq -1$; minimum: −1 **h)** down; (0, 0); $x = 0$; domain: set of real numbers, range: $y \leq 0$; maximum: 0 **i)** down; (0, −3); $x = 0$; domain: set of real numbers, range: $y \leq -3$; maximum: −3 **j)** up; (0, 1); $x = 0$; domain: set of real numbers, range: $y \geq 1$; minimum: 1 **k)** down; (0, 7); $x = 0$; domain: set of real numbers, range: $y \leq 7$; maximum: 7 **l)** down; (0, −6); $x = 0$; domain: set of real numbers, range: $y \leq -6$; maximum: −6 **2. a)** The graph of $y = x^2 - 4$ is a translation of the graph of $y = x^2$ 4 units downward **b)** The graph of $y = -x^2 + 5$ is a translation of the graph of $y = -x^2$ 5 units upward. **c)** The graph of $y = 3x^2$ is a vertical stretch of the graph of $y = x^2$ by a factor of 3. **d)** The graph of $y = -\frac{1}{3}x^2$ is a vertical shrink of the graph of $y = -x^2$ by a factor of $\frac{1}{3}$ **e)** The graph of $y = 2x^2 - 2$ is a translation of the graph of $y = 2x^2 + 7$ 9 units downward. **f)** The graph of

$y = -0.25x^2$ is a reflection of the graph of $y = 0.25x^2$ in the x-axis. **3. a)** $y = -2x^2 + 3$ **b)** $y = 2x^2 - 3$ **c)** $y = 2x^2 + 3$ **d)** $y = -2x^2 - 3$ **4. a)** down; (0, 0); domain: set of real numbers, range: $y \le 0$; maximum: 0 **b)** up; (0, −11.4); domain: set of real numbers, range: $y \ge -11.4$; minimum: −11.4 **c)** down; (0, 4.7); domain: set of real numbers, range: $y \le 4.7$; maximum: 4.7 **d)** up; (0, −3); domain: set of real numbers, range: $y \ge -3$; minimum: −3 **e)** down; (0, −8.3); domain: set of real numbers, range: $y \le -8.3$; maximum: −8.3 **f)** up; (0, 9.9); domain: set of real numbers, range: $y \ge 9.9$; minimum: 9.9 **g)** up; (0, 3.5); domain: set of real numbers, range: $y \ge 3.5$; minimum: 3.5 **h)** down; (0, −0.5); domain: set of real numbers, range: $y \le -0.5$; maximum: −0.5 **5. a)** It becomes the point (2, 13). **b)** It becomes the point (2, −1). **c)** It becomes the point (2, −2). **d)** It becomes the point (2, −2). **6. a)** (0, −9), x-intercepts: ±3, y-intercept: −9 **b)** (0, 1), x-intercepts: none, y-intercept: 1 **c)** (0, 4), x-intercepts: ±2, y-intercept: 4 **d)** (0, −8), x-intercepts: ±2, y-intercept: −8 **e)** (0, 16), x-intercepts: none, y-intercept: 16 **f)** (0, 18), x-intercepts: ±3, y-intercept: 18 **g)** (0, −3), x-intercepts: none, y-intercept: −3 **h)** (0, 5), x-intercepts: ±1, y-intercept: 5 **7. a)** ±1.4 **b)** ±1.7 **c)** no x-intercepts **d)** ±2.2 **e)** ±1.4 **f)** ±2.4

Applications and Problem Solving **8.** −7.5; The graph is symmetric about the y-axis. **9. a)** $A = \frac{1}{2}h^2$ **c)** 0, 0 **d)** domain: $h \ge 0$, range: $A \ge 0$ **10. a)** $y = 5x^2$ **b)** $y = -6x^2$ **c)** $y = -8x^2 - 7$ **d)** $y = 0.2x^2 + 3$ **11.** $k = -15$ **12. b)** 2 m **c)** 150 m **d)** 17 m **13. a)** (−3, 7), (2, 2) **b)** Answers may vary. **14. a)** $y = x^2 + 2$ **b)** $y = -x^2 - 1$ **c)** $y = 2x^2 - 3$ **d)** $y = -\frac{1}{2}x^2 + 4$ **15. a)** $n = 2p^2 - 4$ **b)** $n = -2p^2 + 4$ **c)** They are reflections of each other in the n-axis. **16. a)** $A = \pi r^2$ **c)** No, the domain of the function is $r \ge 0$. **d)** domain: $r \ge 0$, range: $A \ge 0$ **17. a)** $A = 400 - s^2$ **b)** 16 **d)** domain: $0 \le s \le 16$, range: $144 \le A \le 400$ **Technology Extension** Answers may vary.

Modelling Math p. 216

b) 1st quadrant; d and t must be non-negative. **c)** 5.4 s **d)** 13.5 s

Section 4.3 pp. 222–227

Practice **1. a)** up; (−5, 0); $x = -5$; domain: set of real numbers, range: $y \ge 0$; minimum: 0 **b)** down; (−1, 0); $x = -1$; domain: set of real numbers, range: $y \le 0$; maximum: 0 **c)** up; (3, 0); $x = 3$; domain: set of real numbers, range: $y \ge 0$; minimum: 0 **d)** up; (−2, 4); $x = -2$; domain: set of real numbers, range: $y \ge 4$; minimum: 4 **e)** down; (2, −5); $x = 2$; domain: set of real numbers, range: $y \le -5$; maximum: −5 **f)** up; (−3, −5); $x = -3$; domain: set of real numbers, range: $y \ge -5$; minimum: −5 **g)** up; (−6, 2); $x = -6$; domain: set of real numbers, range: $y \ge 2$; minimum: 2 **h)** up; (5, −4); $x = 5$; domain: set of real numbers, range: $y \ge -4$; minimum: −4 **i)** down; (−4, 3); $x = -4$; domain: set of real numbers, range: $y \le 3$; maximum: 3 **2. a)** up; (5, 0); $x = 5$; domain: set of real numbers, range: $y \ge 0$; minimum: 0 **b)** down; (−4, 0); $x = -4$; domain: set of real numbers, range: $y \le 0$; maximum: 0 **c)** up; (2, 1); $x = 2$; domain: set of real numbers, range: $y \ge 1$; minimum: 1 **d)** down; (−1, −2); $x = -1$; domain: set of real numbers, range: $y \le -2$; maximum: −2 **3. a)** up; vertically stretched by a factor of 2; (1, 0); $x = 1$; minimum: 0 **b)** down; vertically shrunk by a factor of 0.5; (−7, 0); $x = -7$; maximum: 0 **c)** down; vertically stretched by a factor of 2; (4, 7); $x = 4$; maximum: 7 **d)** up; vertically stretched by a factor of 4; (−3, −4); $x = -3$; minimum: −4 **e)** down; vertically stretched by a factor of 3; (5, 6); $x = 5$; maximum: 6 **f)** down; vertically shrunk by a factor of 0.4; (8, −1); $x = 8$; maximum: −1 **g)** up; vertically shrunk by a factor of $\frac{1}{3}$; (−6, −7); $x = -6$; minimum: −7 **h)** up; vertically shrunk by a factor of 0.5; (−1, −5); $x = -1$; minimum: −5 **i)** up; vertically stretched by a factor of 2.5; (−1.5, −9); $x = -1.5$; minimum: −9 **j)** down; vertically stretched by a factor of 1.2; (2.6, 3.3); $x = 2.6$; maximum: 3.3 **4. a)** $y = -3(x + 1)^2 + 2$ **b)** $y = 3(x - 1)^2 + 2$ **c)** $y = 3(x + 1)^2 - 2$ **d)** $y = -3(x - 1)^2 - 2$ **6. a)** x-intercept: 2; y-intercept: 4 **b)** x-intercepts: −5, 1; y-intercept: −5 **c)** x-intercepts: 2, 4; y-intercept: 8 **d)** x-intercepts: −3, −1; y-intercept: −3 **7. a)** x-intercepts: −2.7, 0.7; y-intercept: −2 **b)** x-intercepts: −0.4, 2.4; y-intercept: −2 **c)** x-intercepts: $\frac{1}{2}, \frac{3}{2}$; y-intercept: −3 **d)** x-intercepts: none; y-intercept: −47 **e)** x-intercept: −4; y-intercept: 4 **f)** x-intercepts: −5, −1; y-intercept: −2.5

Applications and Problem Solving **8. a)** 83 m **b)** 6.0 s **9. a)** $y = (x - 7)^2$ **b)** $y = -(x + 5)^2$ **c)** $y = 2(x - 3)^2 - 5$ **d)** $y = -3(x - 6)^2 + 7$ **e)** $y = -0.5(x + 1)^2 - 1$ **f)** $y = 1.5(x + 8)^2 + 9$ **10. a)** $y = (x - 1)^2 + 5$ **b)** $y = -(x + 3)^2$ **c)** $y = 3(x - 4)^2 - 2$ **d)** $y = -2(x - 2)^2 - 3$ **e)** $y = 0.4(x + 3)^2 - 3$ **f)** $y = 5(x - 4.5)^2$ **g)** $y = -4(x - 3)^2$ **h)** $y = 2(x + 5)^2 - 6$ **11.** −11 **12.** $x = -1$; The axis of symmetry is halfway between the x-intercepts. It is the vertical line passing through

the midpoint of the line segment joining the x-intercepts. **13.** $x = -3$ **14. a)** 38.5 m **b)** 1 m **c)** 5 s **d)** 25 m **15. a)** 10 m **b)** 20 m **c)** 40 m **d)** 7.5 m **e)** No, the ball would be at a height of 5.1 m, which is too high to jump. **f)** $h = -0.025d^2$ **16. a)** 6 m **b)** 20 m **c)** 2 m; 2 m **d)** 38 m **e)** 2.76 m **17. a)** The graphs in each pair are identical. **b)** $(x - h)^2 = (h - x)^2$ **18. b)** $(-2, -3)$, $(1, 6)$ **c)** Answers may vary. **19. a)** $m = n$ **b)** $m > n$ **c)** $m < n$ **20.** $k = 4$ **21. a)** $y = (x + 4)^2 - 5$ **b)** $y = -(x - 3)^2 + 2$ **c)** $y = -(x - 1)^2 + 6$ **d)** $y = 3(x + 2)^2 + 3$ **e)** $y = -2(x + 5)^2 - 3$ **f)** $y = \frac{1}{2}(x - 6)^2 + 4$ **22. a)** $y = 2(x - 1)^2 + 2$ **b)** $y = -(x + 2)^2 + 3$ **c)** $y = \frac{1}{2}(x - 2)^2 - 4$ **d)** $y = -\frac{1}{4}(x + 4)^2 - 1$ **23. a)** $a = 2$, $k = 4$ **b)** $a = -1$, $k = -4$ **c)** $a = -2$, $k = 5$ **24. a)** vertex on y-axis **b)** vertex on x-axis **c)** vertex at $(0, 0)$ **25. a)** $A = (x - 2)^2 + 3$ **c)** $x = 2$ **d)** 0 **26. a)** $y = -3(x - 2)^2 - 1$ **b)** $y = 3(x + 2)^2 + 1$ **c)** $y = -3(x + 2)^2 - 1$ **27. a)** $(\pm 30, 0.36)$ **b)** $y = 0.0004x^2$ **c)** $y = 0.0004(x + 30)^2 - 0.36$ **d)** $y = 0.0004(x - 30)^2 - 0.36$ **e)** 0.16 cm **Technology Extension** Answers may vary.

Section 4.4 pp. 234–239

Practice 1. a) 49 **b)** 36 **c)** 1 **d)** 81 **e)** 25 **f)** 100 **2. a)** $y = (x + 3)^2 - 6$; $(-3, -6)$, $x = -3$; Points may vary. $(0, 3)$, $(1, 10)$ **b)** $y = (x - 2)^2 - 5$; $(2, -5)$, $x = 2$; Points may vary. $(0, -1)$, $(1, -4)$ **c)** $y = (x + 5)^2 + 5$; $(-5, 5)$, $x = -5$; Points may vary. $(0, 30)$, $(1, 41)$ **d)** $y = (x - 1)^2 + 2$; $(1, 2)$, $x = 1$; Points may vary. $(0, 3)$, $(2, 3)$ **e)** $y = (x + 6)^2 - 8$; $(-6, -8)$, $x = -6$; Points may vary. $(0, 28)$, $(1, 41)$ **f)** $y = (x - 4)^2 - 4$; $(4, -4)$, $x = 4$; Points may vary. $(0, 12)$, $(1, 5)$ **3. a)** $y = x^2 - 4$ **b)** $y = -x^2 + 4x$ **c)** $y = x^2 - 4x$ **d)** $y = x^2 + 4x$ **e)** $y = -x^2 + 4$ **f)** $y = -x^2 - 4x$ **4. a)** $(1, -9)$; $x = 1$; x-intercepts: -2, 4; y-intercept: -8; $y \geq -9$ **b)** $(3, 1)$; $x = 3$; x-intercepts: none; y-intercept: 10; $y \geq 1$ **c)** $(-2, -4)$; $x = -2$; x-intercepts: -4, 0; y-intercept: 0; $y \geq -4$ **d)** $(6, 4)$; $x = 6$; x-intercepts: none; y-intercept: 40; $y \geq 4$ **5. a)** $y = -(x - 4)^2 + 5$; $(4, 5)$; $x = 4$. Points may vary: $(0, -11)$, $(1, -4)$ **b)** $y = -(x + 4)^2 + 9$; $(-4, 9)$; $x = -4$. Points may vary. $(0, -7)$, $(1, -16)$ **c)** $y = -(x + 2)^2 - 3$; $(-2, -3)$; $x = -2$. Points may vary. $(0, -7)$, $(1, -12)$ **d)** $y = -(x + 1)^2 + 1$; $(-1, 1)$; $x = -1$; Points may vary. $(0, 0)$, $(1, -3)$ **6. a)** $(-1, 4)$; $x = -1$; x-intercepts: -3, 1; y-intercept: 3; $y \leq 4$ **b)** $(-2, -8)$; $x = -2$; x-intercepts: none; y-intercept: -12; $y \leq -8$ **c)** $(4, 4)$; $x = 4$; x-intercepts: 2, 6; y-intercept: -12; $y \leq 4$ **d)** $(5, 0)$; $x = 5$; x-intercept: 5; y-intercept: -25; $y \leq 0$ **7. a)** minimum: -7 **b)** maximum: 5 **c)** maximum: 16 **d)** minimum: 0 **e)** minimum: -30 **f)** maximum: 13 **g)** minimum: -28 **h)** maximum: -3 **8. a)** $y = 3(x + 1)^2 - 11$; $(-1, -11)$; $x = -1$; $y \geq -11$ **b)** $y = -2(x + 3)^2 + 18$; $(-3, 18)$; $x = -3$; $y \leq 18$ **c)** $y = 2(x - 1)^2 + 3$; $(1, 3)$; $x = 1$; $y \geq 3$ **d)** $y = -4(x - 1)^2 - 3$; $(1, -3)$; $x = 1$; $y \leq -3$ **e)** $y = 4(x - 2)^2 - 16$; $(2, -16)$; $x = 2$; $y \geq -16$ **f)** $y = -3(x - 2)^2 - 2$; $(2, -2)$; $x = 2$; $y \leq -2$ **9. a)** minimum: 1 at $x = -1$ **b)** maximum: 6 at $x = 5$ **c)** maximum: 7 at $x = -3$ **d)** maximum: -1 at $x = 3$ **e)** minimum: -2 at $x = 2$ **f)** minimum: 2 at $x = 1$ **g)** maximum: 8 at $x = 2$ **h)** maximum: 0 at $x = 1$ **Applications and Problem Solving 10.** 5, -5 **11.** 17, 17 **12. a)** minimum: -14 at $x = -2$ **b)** minimum: -9 at $x = -10$ **c)** maximum: 5 at $x = -5$ **d)** minimum: -5 at $x = 2$ **e)** maximum: 5 at $x = 4$ **f)** maximum: 20 at $x = 100$ **g)** minimum: 1.5 at $x = -1$ **h)** maximum: -0.5 at $x = 3$ **13. a)** $(-2, -1)$ **b)** $(1, -9)$ **c)** $(\frac{3}{4}, -\frac{25}{8})$ **d)** $(-1, 12)$ **14. a)** 20 m **b)** 100 m **c)** 200 m **15. a)** 4.25 m **b)** 5 m **c)** 2 m **16. a)** 46 m **b)** 480 m **c)** 17 m **17. a)** 84 m **b)** 75 m **c)** 71 m **18. a)** 100 m by 100 m **b)** 10 000 m^2 **19.** 15 m **20.** \$30 **21.** 12.5 cm^2 **22. a)** 123.6 m **b)** 7 s **23. a)** The x-coordinates are both 0; the y-coordinates are opposites. **b)** opposite **24. a)** The graph is a straight line. **b)** The graph is a parabola with the y-axis as its axis of symmetry. **25. a)** $k = 9$ **b)** $k < 9$ **c)** $k > 9$ **26. a)** $k = -8$ **b)** $k > -8$ **c)** $k < -8$ **Technology Extension** Answers may vary.

Career Connection p. 239

1. a) $R = (2000 - 100x)(8 + x)$ **b)** (6, 19 600) **c)** \$14 **d)** 1400 **2. a)** People will stop buying because of high price. **b)** People will stop buying because of poor quality.

Modelling Math p. 240

a) Earth: 22 m; Mars: 52 m; Pluto: 402 m
b) Earth: 2 s; Mars: 5 s; Pluto: 40 s

Section 4.5 p. 241

1. a) $y = x(x - 4) - 1$ **b)** $y = x(x - 8) + 6$ **c)** $y = 3x(x - 4) + 4$ **d)** $y = 2x(x - 2) + 3$ **e)** $y = x(x + 2) - 5$ **f)** $y = x(x + 6) + 7$ **g)** $y = 2x(x + 6) - 2$ **h)** $y = -x(x - 4) - 2$ **i)** $y = -4x(x - 2) + 1$ **j)** $y = -2x(x + 2) - 3$

2. Substituting $x = 0$ and $x = s$ into the equation shows that $(0, t)$ and (s, t) are two points on the parabola. Thus, the x-coordinate of the vertex is $\frac{s}{2}$.

Substituting $x = \frac{s}{2}$ into the equation and