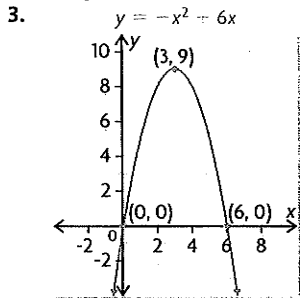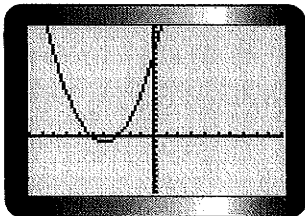## Mid-Chapter Review, page 160

1. a) Yes. The graph has a U shape.
   b) Yes. The degree of the equation is 2.
   c) No. The second differences are not a non-zero constant.

2. a) upward   b) downward

3.

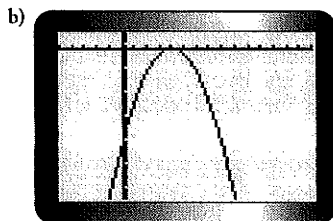

$y = -x^2 + 6x$

   a) $x = 3$ b) $(3, 9)$ c) 0 d) $0, 6$
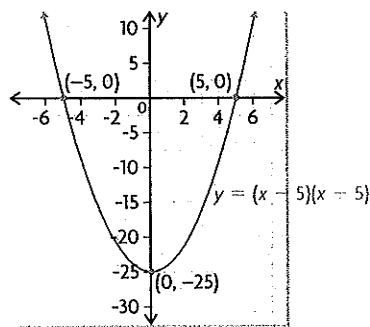
4. $x = 3$

5. a)

   y-intercept: 15;
   zeros: $-3, -5$;
   equation of the axis of symmetry: $x = -4$;
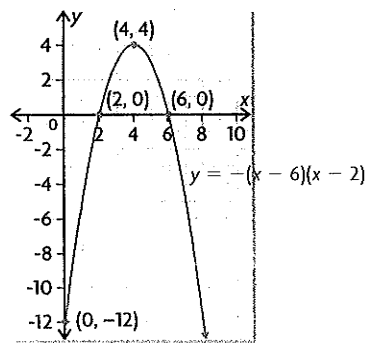   vertex: $(-4, -1)$

   b)

   y-intercept: -32;
   zero: 4;
   equation of the axis of symmetry: $x = 4$;
   vertex: $(4, 0)$

6. a) 0.5 m
   b) about 3 s
   c) 1.5 s
   d) 11.75 m
   e) 0.5 m; the ball is travelling downward because this is after it has reached its maximum height.
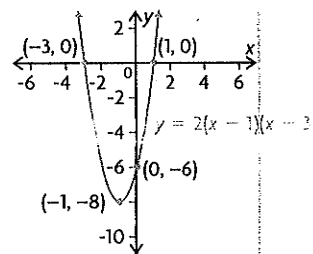   f) about 0.9 s and 2.1 s

7. a) y-intercept: -25; zeros: $-5, 5$;
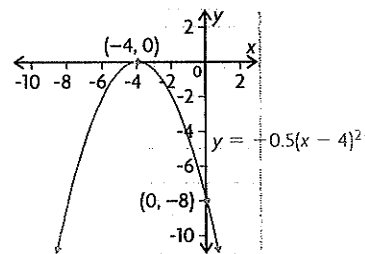   equation of the axis of symmetry: $x = 0$; vertex: $(0, -25)$

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

   b) y-intercept: -12; zeros: 2, 6;
   equation of the axis of symmetry: $x = 4$; vertex: $(4, 4)$

   $y = -(x - 6)(x - 2)$

   c) y-intercept: -6; zeros: $-3, 1$;
   equation of the axis of symmetry: $x = -1$; vertex: $(-1, -8)$
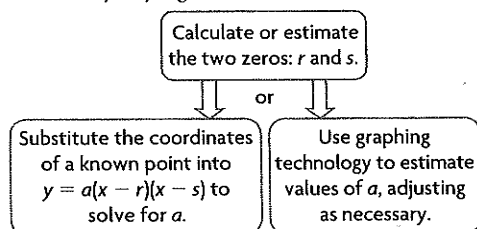

   $y = 2(x - 1)(x + 3)$

   d) y-intercept: -8; zero: -4;
   equation of the axis of symmetry: $x = -4$; vertex: $(-4, 0)$

   $y = -0.5(x + 4)^2$

8. a) $y = -\dfrac{1}{6}(x - 30)(x + 10)$ b) $\left(10, \dfrac{200}{3}\right)$

9. $y = -2(x - 2)(x + 6)$

10. Answers may vary, e.g., $y = (x + 5)(x + 5)$

c) $y = (x + 1)^2 - 1$

d) $(-2, 0), (0, 0)$

e) $y = (-2 + 1)^2 - 1 = 0; y = (0 + 1)^2 - 1 = 0$

f) The value of x must be 1 or greater.

13. No. If the curve does not cross the x-axis, then the factored form cannot be used.

14. Answers may vary, e.g.,

```
Calculate or estimate
the two zeros: r and s.
           |
          or
     ↓            ↓
Substitute the coordinates    Use graphing
of a known point into         technology to estimate
y = a(x − r)(x − s) to        values of a, adjusting
solve for a.                  as necessary.
```

15. a) 449

b) Model 25

## Lesson 3.6, page 181

1. a) 3^0

b) $\dfrac{3 \times 3 \times 3 \times 3}{3 \times 3 \times 3 \times 3} = \dfrac{1}{1} = 1$

c) Any non-zero base with exponent 0 is equal to 1.

d) $\dfrac{5^3}{5^3} = 5^0 = \dfrac{5 \times 5 \times 5}{5 \times 5 \times 5} = \dfrac{1}{1} = 1$

2. a) 3^{-1}

b) $\dfrac{3 \times 3 \times 3}{3 \times 3 \times 3 \times 3} = \dfrac{1}{3}$

c) Any non-zero base with the exponent -1 is equal to the reciprocal of the base.

d) $\dfrac{5^2}{5^4} = 5^{-2} = \dfrac{5 \times 5}{5 \times 5 \times 5 \times 5} = \dfrac{1}{5^2}$

e) $\dfrac{5^2}{5^5} = 5^{-3} = \dfrac{5 \times 5}{5 \times 5 \times 5 \times 5 \times 5 \times 5} = \dfrac{1}{5^3}$

3. a) $\dfrac{1}{16}$ b) $\dfrac{1}{4}$ c) 1 d) $\dfrac{1}{25}$ e) $\dfrac{1}{81}$ f) $\dfrac{1}{49}$

4. a) $-\dfrac{1}{32}$ b) $-\dfrac{1}{16}$ c) -1 d) $-\dfrac{1}{5}$ e) $\dfrac{1}{9}$ f) $-\dfrac{1}{64}$

5. a) $\dfrac{1}{4}$ b) 4 c) $\dfrac{8}{27}$ d) $\dfrac{27}{8}$ e) $-\dfrac{16}{9}$ f) $\dfrac{16}{9}$

6. a) -3 b) 3 c) 0 d) 3 e) -2 f) 2 or -2

7. 5^{-2} is greater. It will have a denominator that is less when it is written in rational form.

8. $(-1)^{-101}$ is less. Since it has an odd exponent, it will equal -1. In comparison, $(-1)^{-100}$ has an even exponent and will equal 1.

Chapter 3 Review, page 185

1. a) No. It is a first degree, or linear, relation.

b) Yes. The second differences are constant and non-zero.

c) Yes. It is a second degree relation.
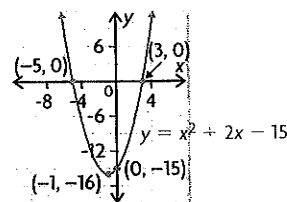
d) Yes. It is a symmetrical U shape.

2. Increasing a makes the parabola narrower; increasing b shifts the parabola down and to the left; increasing c shifts the parabola up.
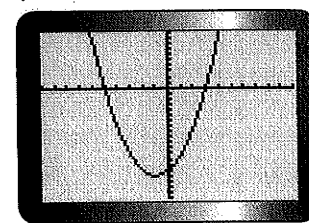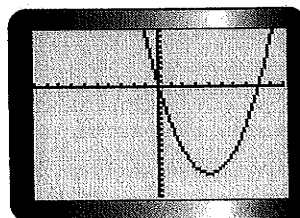
3. a)
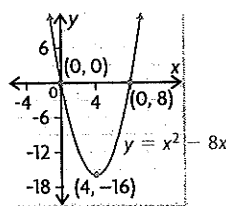
i) $x = 4$ ii) $(4, -16)$ iii) 0 iv) 0, 8

b)

i) $x = -1$ ii) $(-1, -16)$ iii) -15 iv) $-5, 3$

4. a)   b)

5. a) maximum, because the second differences are negative

b) positive, because it is between the zeros and the curve opens downward
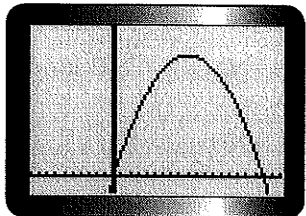
c) 1.5

6. Answers may vary, e.g.,

x	y	First Difference	Second Difference
1	2		
		5	
2	7		2
		7	
3	14		2
		9	
4	23		2
		11	
5	34		

x	y	First Difference	Second Difference
1	1		
		6	
2	7		4
		10	
3	17		4
		14	
4	31		4
		18	
5	49		

x	y	First Difference	Second Difference
1	2		
		5	
2	7		−1
		4	
3	11		−1
		3	
4	14		−1
		2	
5	16		

Each table of values represents a parabola because the second differences are constant and not zero.

7. **a) i)** 0, 18 **ii)** $x = 9$ **iii)** $(9, 81)$

b) i) 0, −2.5 **ii)** $x = -1.25$ **iii)** $(-1.25, -9.375)$
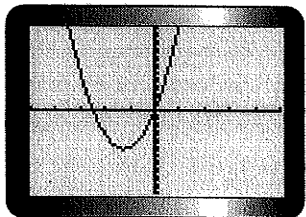
8. Answers may vary, e.g., the greater the value of a, the narrower the parabola is. Also, a positive a means that the parabola opens upward; and a negative a means that the parabola opens downward.

9. **a)** either 2000 or 5000
   b) 3500

10. **a)** $y = 2(x + 2)(x - 7)$ **b)** $(2.5, -40.5)$

11. **a)** $y = 0.5(x - 5)(x - 9)$ **d)** $y = 0.5(x - 4)^2$
   b) $y = -0.16(x + 3)(x - 7)$ **e)** $y = -4(x - 3)(x + 3)$
   c) $y = 0.75(x + 6)(x - 2)$

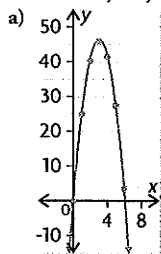**12.** $2.00

13. **a)** $2x^2 + 3x - 9 = (x + 3)(2x - 3)$
   b) $15x^2 - 38x + 24 = (5x - 6)(3x - 4)$

14. **a)** $x^2 + 9x + 20$ **d)** $12x^2 + 7x - 10$
   b) $x^2 - 7x + 10$ **e)** $20x^2 + 2xy - 6y^2$
   c) $4x^2 - 9$ **f)** $30x^2 + 32x - 14$

15. **a)** $4x^2 + 24x + 36$ **c)** $32x^3 - 2xy^2$
   b) $12x^2 - 14x - 40$

16. $y = -0.25x^2 + x + 8$

17. Answers may vary, e.g.,
   a)

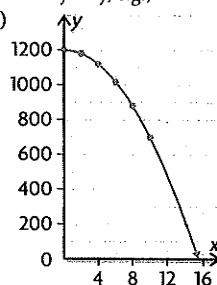**b)** Yes. It is a symmetrical curve with a U shape.
c) $y = -5x^2 + 30.5x$
d) about 36 m
e) about 0.7 s and about 5.4 s

18. Answers may vary, e.g.,
   a), b)

c) Yes. The equation to describe the curve is degree 2.
d) $y = -5x^2 + 1200$
e) about 15.5 s

19. **a)** $\dfrac{1}{8}$ **c)** $\dfrac{25}{4}$ **e)** $\dfrac{1}{64}$

   b) $-\dfrac{1}{5}$ **d)** 1 **f)** -36

20. 3^{-2} is greater, for example, because it equals $\left(\dfrac{1}{3}\right)^2$, which has a denominator that is less than the denominator of $\left(\dfrac{1}{4}\right)^2$.

21. Answers may vary, e.g., using graphing technology, I can see that x^2 is greater than 2^x when x is between 2 and 4.

Chapter Self-Test, page 187

1. zeros: $-6, 2$; vertex: $(-2, -4)$; equation of the axis of symmetry: $x = -2$

2. **a)** $x = 5$

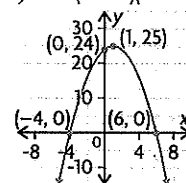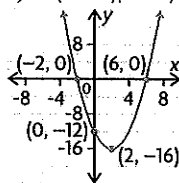   **b)** $y = \dfrac{1}{7}(x + 9)(x - 19)$

   c) $y = \dfrac{1}{7}x^2 - \dfrac{10}{7}x - \dfrac{171}{7}$

3. **a)** Yes. The second differences are constant.
   b) Yes. The second differences are constant.

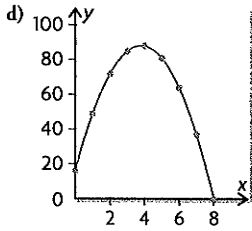**4.** **a)** $y = (x - 6)(x - 2)$ **b)** $y = -(x - 6)(x + 4)$

5. **a)** 51 600
   b) Answers may vary, e.g., between 1974 and 1983

6. **a)** $10x^2 - 11x - 6$
   b) $15x^2 - 14xy - 8y^2$
   c) $-5x^2 + 40x - 80$

Answers

7. Answers may vary, e.g.,
a) 16 m
b) 8 s
c) Yes. The second differences are constant and non-zero.
d)

e) $y = -5x^2 + 38x + 16$
f) about 88 m

8. Answers may vary, e.g., in both cases, we try to find an equation that describes the relationship. Using a quadratic relation is generally more difficult because parabolas can be harder to match to data as they all have different shapes (narrower or wider openings). This gives more flexibility, however, and can be used to model a wider variety of relationships.

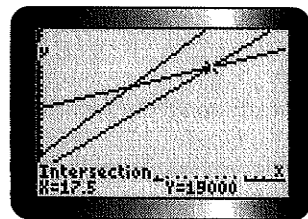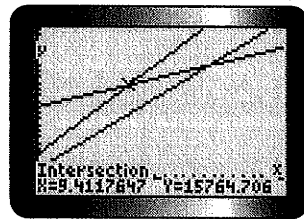**9.** a) $\dfrac{1}{49}$ b) -1 c) $-\dfrac{81}{16}$ d) $-\dfrac{1}{125}$

Cumulative Review Chapters 1–3, page 189

1. C	**6.** B	**11.** B	**16.** A	**21.** D
2. B	**7.** A	**12.** D	**17.** B	**22.** A
3. A	**8.** C	**13.** A	**18.** B	**23.** B
4. D	**9.** D	**14.** D	**19.** C	**24.** D
5. C	**10.** B	**15.** B	**20.** C	

25. a) gas: $C = 4000 + 1250t$; electric: $C = 1500 + 1000t$; geothermal: $C = 12\,000 + 400t$
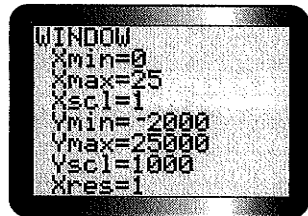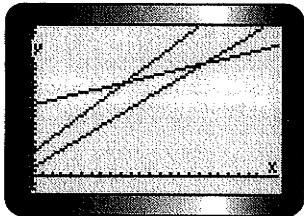

b)

Electric baseboard heaters are the least expensive for the first 17.5 years. A gas furnace is more expensive than electric baseboard heaters, but it is less expensive than a geothermal heat pump for the first 9.4 years. After 17.5 years, the geothermal heat pump is the least expensive.

c) Answers may vary, e.g., The choice depends on how long Jenny and Oliver plan to live in the house. Another factor that they should consider is the uncertainty about gas and electricity prices over time. Geothermal costs will remain relatively stable.

26. a)
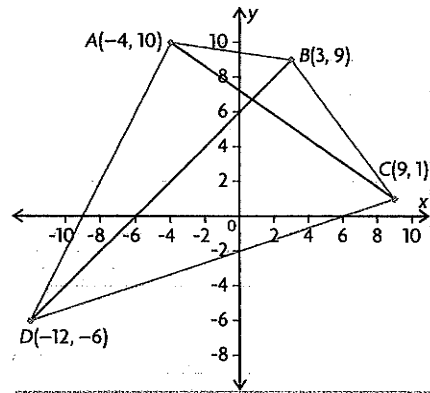
Answers may vary, e.g., If all four perpendicular bisectors intersect at the same location, you can draw a circle that passes through all four vertices. The centre of this circle is the point of intersection of the perpendicular bisectors. Determine the equations of the perpendicular bisectors, and then solve the linear system that is formed by two of these equations. Check to see if the solution satisfies the other equations.

b) perpendicular bisector of AD: $y = -0.5x - 2$; perpendicular bisector of DC: $y = -3x - 7$; perpendicular bisector of CB: $y = 0.75x + 0.5$; perpendicular bisector of BA: $y = 7x + 13$
All four lines intersect at $(-2, -1)$, so it is possible to draw a circle that passes through all four vertices. Therefore, quadrilateral $ABCD$ is cyclic.