Prerequisite Skills

1. a) –17   **b)** 58   **c)** –18   **d)** $-\dfrac{2543}{256}$

2. a) $2x^4 - 5x^3 - 4x^2 + 11x - 1$
   b) $3x^4 + 10x^3 - x^2 - 14x - 11$
   c) $x^2 - 6$ **d)** $x^2 - 28$ **e)** $x^2 + 6x + 4$

3. a) $(x - 7)(x + 7)$
   b) $(8a - 11b)(8a + 11b)$
   c) $3(m - 5n)(m + 5n)$
   d) $5(x - 1)(x + 1)(x^2 + 1)$

4. a) $(b - 5)(b + 3)$ **b)** $(m - 3)(m - 6)$
   c) $(2a + 3)(a - 4)$ **d)** $(3x - 2)(x - 5)$
   e) $(2x + 1)(3x - 4)$

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

   c) $x = -\dfrac{5}{3}$ or $x = \dfrac{5}{3}$ **d)** $x = -\dfrac{1}{2}$ or $x = 6$

   e) $x = -\dfrac{1}{2}$ or $x = \dfrac{7}{5}$

6. a) $x \doteq 0.2$ or $x \doteq 1.4$
   b) $x \doteq -3.9$ or $x \doteq 0.9$
   c) $x \doteq -1.1$ or $x \doteq 2.9$

7. a) $y = x^2 - 3x - 10$ **b)** $y = -2x^2 + 12x$
   c) $y = -24x^2 - 52x + 20$

8. a) i) –1 and 3
   ii) above the x-axis: $-1 < x < 3$; below
      the x-axis: $x < -1$ or $x > 3$
   b) i) –2, 1, and 3
   ii) above the x-axis: $x < -2$ or $1 < x < 3$;
      below the x-axis: $-2 < x < 1$ or $x > 3$

2.1 The Remainder Theorem

1. a) $2x^2 - 7x + 15 + \dfrac{-36}{x + 2}$

   b) $x \neq -2$
   c) $(2x^2 - 7x + 15)(x + 2) - 36$

2. a) $\dfrac{x^3 + 2x^2 - 5x + 3}{x + 2} = x^2 - 5 + \dfrac{13}{x + 2}$,
   $x \neq -2$

   b) $\dfrac{4x^3 + 3x - 4}{2x + 1} = 2x^2 - x + 2 + \dfrac{-6}{2x + 1}$,
   $x \neq -\dfrac{1}{2}$

c) $\dfrac{-9x^4 + 6x^3 + 6x - 5}{3x - 2} =$

   $-3x^3 + 2 + \dfrac{-1}{3x - 2}$, $x \neq \dfrac{2}{3}$

d) $\dfrac{8x^3 - 10x^2 - 21}{x - 3} =$

   $8x^2 + 14x + 42 + \dfrac{105}{x - 3}$, $x \neq 3$

3. a) –5   **b)** 10

4. $(2x - 3)$ cm by $(2x - 3)$ cm by $(x - 4)$ cm
One possible answer: 7 cm by 7 cm by 1 cm

5. a) 34   **b)** –50   **c)** 8

6. a) 5

7. –5

8. $4\dfrac{40}{81}$

9. a) –1

10. a) 0   **b)** $x(2x + 1)(4x - 1)$

11. $m = \dfrac{5}{3}$, $n = \dfrac{11}{3}$

2.2 The Factor Theorem

1. a) not a factor   **b)** factor
   c) factor

2. a) $\pm 1, \pm 2$; $(x - 2)(x - 1)(x + 1)$
   b) $\pm 1, \pm 2, \pm 3, \pm 6$; $(x + 2)(x + 1)(x - 3)$
   c) $\pm 1, \pm 2, \pm 3, \pm 4, \pm 6, \pm 8, \pm 12,$
      ± 24; $(x + 4)(x + 3)(x - 2)$

3. a) $(x + 2)(x - 3)(x + 3)$
   b) $(2x + 5)(x - 2)(x + 2)$
   c) $(x - 3)(x - 5)(x + 5)$
   d) $(3x - 5)(x - 3)(x + 3)$

4. a) $\pm 1, \pm 2, \pm 4, \pm 8$; $(x - 1)(x - 2)(x + 4)$

   b) $\pm 1, \pm 2, \pm \dfrac{1}{2}$; $(2x - 1)(x + 1)(x + 2)$

   c) $\pm 1, \pm 2, \pm 3, \pm 6, \pm \dfrac{1}{2}, \pm \dfrac{3}{2}$;

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

   d) $\pm 1, \pm 2, \pm 3, \pm 6, \pm \dfrac{1}{3}, \pm \dfrac{2}{3}$;

      $(3x - 1)(x - 2)(x - 3)$

5. a) $(x + 1)(x - 1)(x + 5)$
   b) $(x - 1)(x - 2)(x + 3)$
   c) $(x - 3)(x + 2)(x - 2)$
   d) $(x + 1)(x + 2)(x - 2)(x + 3)$
   e) $(x - 1)(x - 2)(x + 4)(x - 4)$

6. a) $(2x + 1)(x - 2)(x + 3)$
   b) $(x + 1)(4x - 1)(x - 3)$
   c) $(x - 4)(x + 2)(5x - 2)$
7. -1
8. -6
9. a) $(x - 3)(2x - 5)(2x - 7)$
   b) 2.2 m by 5.4 m by 3.4 m
10. a) $(2x + 3)(x - 1)(x + 5)$
   b) $(3x - 1)(x + 1)(x + 2)$
   c) $(5x - 2)(x - 1)(x - 2)$
   d) $(4x + 1)(x + 3)(x - 2)$
11. a) $(2x - 5)(4x^2 + 10x + 25)$

   b) $\left(4x + \dfrac{2}{3}\right)\left(16x^2 - \dfrac{8}{3}x + \dfrac{4}{9}\right)$

   c) $(6x + y)(36x^2 - 6xy + y^2)$
   d) $(3 - t^2)(9 + 3t^2 + t^4)$

   e) $\left(5x^2 - \dfrac{1}{4}y\right)\left(25x^4 + \dfrac{5}{4}x^2 y + \dfrac{1}{16}y^2\right)$

   f) $(2x^2 + 7y^4)(4x^4 - 14x^2y^4 + 49y^8)$
12. a) $(4x - 1)(4x + 1)(x - 1)(x + 1)$
   b) $(3x - 5)(3x + 5)(x - 2)(x + 2)$

13. $y = -\dfrac{1}{7}(x - 2)(3x - 2)(x + 4)$

14. $(x - 1)(x + 2)(x - 3)(3x + 1)(x + 1)$

2.3 Polynomial Equations
1. a) $x = 0$ or $x = 1$ or $x = 3$

   b) $x = -\dfrac{1}{2}$ or $x = 3$ or $x = -3$

   c) $x = \dfrac{2}{3}$ or $x = 2$ or $x = -2$

2. a) $x = -2$ or $x = \dfrac{1}{2}$ or $x = 3$

   b) $x = -3$ or $x = -1$ or $x = 5$

   c) $x = -\dfrac{1}{2}$ or $x = \dfrac{1}{4}$ or $x = 1$

3. a) $x = -2$ or $x = 1$ or $x = 3$
   b) $x = -5$ or $x = -3$ or $x = 2$
   c) $x = -4$ or $x = -2$ or $x = 0$
4. a) $x = 1$
   b) $x = 5$ or $x = -5$
   c) $x = 4$ or $x = -4$
   d) $x = 3$ or $x = -3$ or $x = 1$
5. a) 1   **b)** -3
   c) $-2, -3, 3$ **d)** $-4, -3, 3, 4$

6. a) $x = -2$ or $x = 1$ or $x = 3$
   b) $x = -2$ or $x = -1$ or $x = 0$ or $x = 4$
   c) $x = 0$ or $x = -2$ or $x = 2$

   d) $x = -4$ or $x = -\dfrac{1}{2}$ or $x = 3$

   e) $x = -2$ or $x = -1$ or $x = \dfrac{2}{3}$

   f) $x = -5$ or $x = -1$ or $x = 1$ or $x = 5$
7. a) $x \approx 0.13$
   b) $x \approx -0.68$ or $x \approx 5.66$
   c) $x \approx -1.47$
   d) $x \approx -1.31$ or $x \approx 1.51$
8. 2.86 m by 7.93 m by 4.86 m
9. 10 cm by 10 cm by 5 cm

10. $x = 1$ or $x = \dfrac{-15 \pm i\sqrt{111}}{6}$

11. $x^3 - 19x^2 + 123x - 265 = 0$

2.4 Families of Polynomial Functions
1. a) $y = k(x + 3)(x - 5),\ k \in \mathbb{R},\ k \neq 0$
   b) Answers may vary.

   c) $y = -\dfrac{1}{2}(x + 3)(x - 5)$

2. D (has different zeros)
3. C (has different zeros)
4. a) $y = -2x(x + 2)(x - 3)$

   b) $y = \dfrac{1}{2}x(x + 2)(x - 3)$

   c) $y = \dfrac{1}{2}x(x - 4)(x + 2)$

5. A, C, and D (zeros are $-3, -1, 4$); B, E, and F (zeros are $-4, -3, 1$)
6. a) i) $y = k(x + 5)(x - 2)(x - 7)$
   ii) $y = k(x + 6)(x + 2)(x - 3)$
   iii) $y = k(x + 4)(x + 1)(x - 2)(x - 5)$

   b) i) $y = \dfrac{2}{9}(x + 5)(x - 2)(x - 7)$

   ii) $y = -\dfrac{4}{21}(x + 6)(x + 2)(x - 3)$

   iii) $y = \dfrac{1}{5}(x + 4)(x + 1)(x - 2)(x - 5)$

7. a) $y = k(x + 2)(x - 2)(x - 5)$
   b) Answers may vary.

   c) $y = \dfrac{1}{2}(x + 2)(x - 2)(x - 5)$

   d) Answers may vary.

8. a) $y = k(x)(x + 4)(x + 1)(x - 3)$
  b) Answers may vary.
  c) $y = -x(x + 4)(x + 1)(x - 3)$
  d) Answers may vary.
9. a) $y = k(2x + 3)(x - 1)(2x - 5)$
  b) $y = -2(2x + 3)(x - 1)(2x - 5)$
  c)
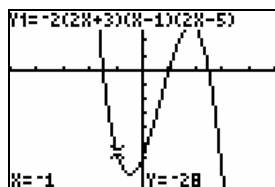
10. a) $y = k(x^3 - 10x^2 + 29x - 26)$
  b) $y = 3(x^3 - 10x^2 + 29x - 26)$

11. $y = \dfrac{3}{4}(x + 2)(x - 1)(x - 4)$

12. a) $y = k(x^4 + 4x^3 - 7x^2 - 2x + 4)$
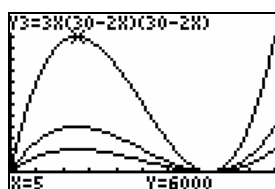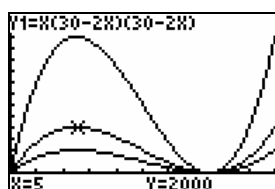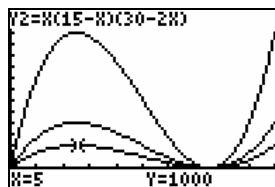 **b)** $y = -3(x^4 + 4x^3 - 7x^2 - 2x + 4)$
13. a) $V(x) = x(30 - 2x)(30 - 2x)$
  b) i) $V(x) = x(15 - x)(30 - 2x)$
  ii) $V(x) = 3x(30 - 2x)(30 - 2x)$
  c) They all have the same zeros.
  d)

  e) 3 cm by 24 cm by 24 cm or 7.3 cm by
    15.4 cm by 15.4 cm
14. a) Answers may vary. Sample answer:
    $y = k(x)(2x - 5)(2x + 5)$
  b) $y = -8x^3 + 50x$
  c) $y = 8x^3 - 50x$
  d) It is an odd function, since
    $f(-x) = -f(x)$.

2.5 Solve Inequalities Using Technology

1. a) $-4 \le x \le 2$ **b)** $-6 < x < -1$
c) $-2 < x \le 5$ **d)** $1 \le x < 3$
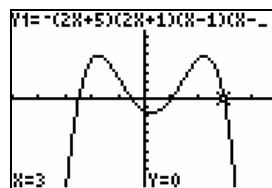**2. a)** $x < -7, -7 < x < -1, x > -1$
  b) $x < 3, 3 < x < 4, x > 4$
  c) $x < -2, -2 < x < 0, 0 < x < 6, x > 6$
3. a) intervals where $f(x)$ is above the x-axis
  b) intervals where $f(x)$ is on or below the
    x-axis
4.

5. a) i) $-3, 4$ **ii)** $-3 < x < 4$
  iii) $x < -3, x > 4$
  b) i) $-5, 2$ **ii)** $x < -5, x > 2$
  iii) $-5 < x < 2$
  c) i) $-2, 1, 5$ **ii)** $-2 < x < 1, x > 5$
  iii) $x < -2, 1 < x < 5$
  d) i) $-3, -1, 2, 4$
  ii) $-3 < x < -1, 2 < x < 4$
  iii) $x < -3, -1 < x < 2, x > 4$
6. a) $-2 \le x \le 4$
  b) $x < -6$ or $x > -1$
  c) $-4 \le x \le -1$ or $x \ge 4$
  d) $x < -2$ or $1 < x < 3$
  e) $x \le -3$ or $2 \le x \le 5$
7. a) $-0.5 < x < 3$
  b) $x \le 2.5$ or $x \ge 4.5$
  c) $-1 < x < 2$ or $x > 3$
  d) $x \le -3$ or $-1 \le x \le 3$
  e) $-2 \le x \le 3$ or $x \ge 5$
8. a) $x \le 0.22$ or $x \ge 2.28$
  b) $x < -1.34$ or $-0.32 < x < 1.16$
  c) $x < 0.92$
  d) $x \le -2.66$ or $-1.21 \le x \le 1.87$
  e) $0.77 < x < 1.31$
9. a) $x > 2.7$ **b)** $x < 0.5$
  c) $-3.4 \le x \le 0.5$ or $x \ge 2.9$
  d) $1.3 \le x \le 2.8$
10. from 0 s to 0.32 s and between 6.21 s
    and 6.54 s
11. Answers may vary. Sample answer:
    $8x^4 - 68x^3 + 34x^2 + 425x - 525 > 0$
12. $x \le 0.68$ or $x \ge 1.14$

2.6 Solve Factorable Polynomial Inequalities Algebraically
1. a) $x > 3$　　　　　　**b)** $x \le -2$
　c) $x > 4$　　　　　　**d)** $x \ge 1$
2. a) $x \le -2$ or $x \ge 3$

　b) $-\dfrac{1}{2} < x < 2$

3. a) $x < -4$ or $x > \dfrac{5}{3}$　　**b)** $-\dfrac{2}{3} \le x \le 1$

4. a) $-2 \le x \le 4$ or $x \ge 6$

　b) $x \le -\dfrac{5}{3}$ or $\dfrac{1}{2} \le x \le 3$

　c) $1 < x < \dfrac{3}{2}$ or $x > 2$

　d) $-1 < x < \dfrac{2}{3}$ or $x > \dfrac{2}{3}$

5. a) $-5 < x < 2$
　b) $x \le -7$ or $x \ge -3$

　c) $x \le -2$ or $-\dfrac{1}{2} \le x \le 1$

　d) $-2 < x < \dfrac{1}{3}$ or $x > 2$

6. a) $-2 \le x \le 1$ or $x \ge 3$
　b) $x < -1$ or $2 < x < 4$

　c) $x < 0$ or $\dfrac{2}{3} < x < 1$

　d) $-3 \le x \le -1$ or $0 \le x \le 4$
7. a) $-4 < x < 6$
　b) $-3 \le x \le -2$ or $x \ge -1$

　c) $x < -\dfrac{1}{2}$ or $1 < x < 3$

　d) $-1 \le x \le 2$ or $x \ge 4$
8. 31 cm by 10 cm by 3 cm

9. $-2 \le x \le -1$ or $1 \le x \le \dfrac{3}{2}$ or $x \ge 2$

Chapter 2 Review
1. a) i) 21

　ii) $\dfrac{x^3 + 4x^2 - 3}{x - 2} = x^2 + 6x + 12 + \dfrac{21}{x-2}$,

　$x \ne 2$
　b) i) 254

　ii) $\dfrac{3x^3 - 5x^2 + 2x - 6}{x - 5} =$

　$3x^2 + 10x + 52 + \dfrac{254}{x-5}$, $x \ne 5$

c) i) –18　**ii)** $\dfrac{2x^4 - 3x^3 - 4x^2 + 5x - 15}{2x + 1} =$,

　$x^3 - 2x^2 - x + 3 + \dfrac{-18}{2x+1}$, $x \ne -\dfrac{1}{2}$

2. a) 15
3. –10
4. a) $\pm 1, \pm 2, \pm 4, \pm 8; (x-1)(x-2)(x+4)$

　b) $\pm 1, \pm 2, \pm \dfrac{1}{2}; (2x+1)(x+1)(x+2)$

　c) $\pm 1, \pm 2, \pm 4, \pm 8, \pm \dfrac{1}{3}, \pm \dfrac{2}{3}, \pm \dfrac{4}{3},$

　$\pm \dfrac{8}{3}; (x+1)(x+2)(3x-2)(x-2)$

5. a) $(x-3)^2(x+3)$
　b) $(x+1)(2x-5)(2x+5)$
　c) $(x+2)(3x-2)(3x+2)$
6. –50

7. $\dfrac{1}{12}$

8. a) $(x-20)$ cm by $(x-5)$ cm by $(x-8)$ cm
b) 5 cm by 20 cm by 17 cm
9. $x = -5$ or $x = -1$ or $x = 2$

10. a) $\dfrac{4}{3}$　　　　**b)** 2　　　　**c)** –5, –2, 2, 5

11. a) $x = -2$ or $x = 5$
　b) $x = 3$ or $x = 5$ or $x = -5$
12. a) $x \doteq -1.23$
　b) $x \doteq -1.46$ or $x \doteq 1.34$ or $x \doteq 4.62$
　c) $x \doteq -1.22$ or $x \doteq 0.38$
13. a) $V(x) = x(x-6)(1.5x-3)$
　b) 20.68 cm by 14.68 cm by 28.02 cm
14. a) $y = k(2x+1)(x-2)(x-6)$
　b) Answers may vary.
　c) $y = -2(2x+1)(x-2)(x-6)$
15. a) $y = k(x^3 + x^2 - 11x - 15)$
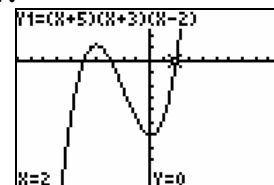
　b) $y = \dfrac{2}{3}(x^3 + x^2 - 11x - 15)$

16. a) $x \ge 4.22$
　b) $x < -1.15$ or $0 < x < 1.15$
　c) $-2.81 \le x \le 0.76$
　d) $x < -1.02$
17.

18. a) $x \le -2$ or $x \ge -\dfrac{5}{4}$

b) $-\dfrac{5}{2} \le x \le \dfrac{1}{3}$ or $x \ge 3$

c) $x < -3$ or $-3 < x < -\dfrac{3}{2}$ or $x > \dfrac{3}{2}$

19. a) $-\dfrac{5}{2} < x < 3$

b) $x < -3$ or $-1 < x < 3$
c) $-5 \le x \le 5$

Chapter 2 Test
1. C
2. C
3. B
4. a) $\dfrac{3x^3 - x^2 - 1}{x + 2} = 3x^2 - 7x + 14 + \dfrac{-29}{x + 2}$

b) $x \ne -2$
c) $(3x^2 - 7x + 14)(x + 2) - 29$

5. a) 19   **b)** $\dfrac{81}{16}$

6. a) $(x - 5y)(x^2 + 5xy + 25y^2)$
   b) $(x - 3)(x + 3)(x - 4)$
   c) $(x - 1)(x + 2)(x + 3)$
   d) $(3x - 1)(x + 2)(x + 1)$
   e) $(x - 1)(x + 2)(x - 3)(x - 2)$
7. $x = -4$ or $x = -1$ or $x = 1$ or $x = 3$

8. a) $x = -\dfrac{3}{2}$ or $x = 0$ or $x = 2$

   b) $x = -2$ or $x = 1$ or $x = 3$

   c) $x = -2$ or $x = -1$ or $x = -\dfrac{1}{2}$ or $x = 2$

9. $y = -(x + 4)(x + 1)(x - 2)$
10. $y = x^4 - 6x^3 + 5x^2 + 10x + 2$
11. a) $x \ge 2.2$ **b)** $-0.5 < x < 1.2$
12. a) $x \le -4$ or $x \ge 4$
   b) $-2 < x < 0$ or $x > 4$
   c) $x < -1$ or $-1 < x < 2$ or $x > 3$
13. a) $V(x) = x(36 - 2x)(52 - 2x)$
   b) $1.96 < x < 13.52$
   c) 1.96 cm by 32.08 cm by 48.08 cm or
      13.52 cm by 8.96 cm by 24.96 cm