C H A P T E R 5
Polynomials and Factoring

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C H A P T E R 5
Polynomials and Factoring

Section 5.1 Integer Exponents and Scientific Notation

Solutions to Even-Numbered Exercises

2. (a) $5^2y^4 \cdot y^2 = 25(y^4 \cdot y^2) = 25y^{4+2} = 25y^6$

(b) $(5y)^2 \cdot y^4 = 25y^2 \cdot y^4 = 25(y^2 \cdot y^4) = 25y^{2+4} = 25y^6$

4. (a) $(-5z^3)^2 = (-5)^2(z^3)^2 = 25z^{3\cdot 2} = 25z^6$

(b) $(-5z)^4 = (-5)^4z^4 = 625z^4$

6. (a) $(6xy^7)(-x) = -6 \cdot x \cdot x \cdot y^7 = -6x^{1+1}y^7 = -6x^2y^7$

(b) $(x^5y^3)(2y^3) = 2 \cdot x^5 \cdot y^{3+3} = 2x^5y^6$

8. (a) $(3y)^3(2y^2) = (3)^3y^3(2y^2)$

$= 27 \cdot 2 \cdot y^3 \cdot y^2$

$= 54y^{3+2}$

$= 54y^5$

(b) $3y^3 \cdot 2y^2 = 3 \cdot 2 \cdot y^3 \cdot y^2$

$= 6y^{3+2}$

$= 6y^5$

10. (a) $-(m^3n^2)(mn^3) = -(m^3n^2)(mn^3) = -m^{3+1} \cdot n^{2+3}$

$= -m^4n^5$

(b) $-(m^3n^2)^2(-mn^3) = -(m^3)^2(n^2)^2(-mn^3)$

$= -m^6n^4(-1)mn^3$

$= m^6mn^4n^3$

$= m^{6+1}n^{4+3}$

$= m^7n^7$

12. (a) $\dfrac{28x^2y^3}{2xy^2} = \dfrac{28}{2} \cdot \dfrac{x^2}{x} \cdot \dfrac{y^3}{y^2}$

$= \dfrac{28}{2} \cdot x^{2-1} \cdot y^{3-2}$

$= 14xy$

(b) $\dfrac{24xy^2}{8y} = \dfrac{24}{8} \cdot x \cdot \dfrac{y^2}{y}$

$= \dfrac{24}{8} \cdot x \cdot y^{2-1}$

$= 3xy$

14. (a) $\left(\dfrac{2a}{3y}\right)^5 = \dfrac{(2)^5a^5}{(3)^5y^5} = \dfrac{32a^5}{243y^5}$

(b) $-\left(\dfrac{2a}{3y}\right) = -\dfrac{(2)^2a^2}{(3)^2y^2} = -\dfrac{4a^2}{9y^2}$

16. (a) $\dfrac{(-4xy)^3}{8xy^2} = \dfrac{(-4)^3x^3y^3}{8xy^2} = \dfrac{-64x^3y^3}{8xy^2} = -8x^2y$

(b) $\dfrac{(-xy)^4}{-3(xy)^2} = \dfrac{(-1)^4x^4y^4}{-3x^2y^2} = \dfrac{x^4y^4}{-3x^2y^2} = -\dfrac{x^2y^2}{3}$

18. (a) $\left[\dfrac{(3x^2)(2x)^2}{(-2x)(6x)}\right]^2 = \left[\dfrac{(3x^2)(4x^2)}{-12x^2}\right]^2$

$= \left[\dfrac{12x^4}{-12x^2}\right]^2$

$= [-x^2]^2$

$= x^4$

(b) $\left[\dfrac{(3x^2)(2x)^4}{(-2x)^2(6x)}\right]^2 = \left[\dfrac{(3x^2)(16x^4)}{(4x^2)(6x)}\right]^2$

$= \left[\dfrac{48x^6}{24x^3}\right]^2$

$= [2x^3]^2$

$= (2)^2(x^3)^2$

$= 4x^6$

20. (a) $\dfrac{x^{3n}y^{2n-1}}{x^n y^{n+3}} = x^{3n-n}y^{(2n-1)-(n+3)} = x^{2n}y^{2n-1-n-3} = x^{2n}y^{n-4}$ (b) $\dfrac{x^{4n-6}y^{n+10}}{x^{2n-5}y^{n-2}} = x^{4n-6-(2n-5)}y^{(n+10)-(n-2)}$
$= x^{4n-6-2n+5}y^{n+10-n+2} = x^{2n-1}y^{12}$

22. $2^{-4} = \dfrac{1}{2^4} = \dfrac{1}{16}$

24. $-20^{-2} = -\dfrac{1}{20^2}$
$= -\dfrac{1}{400}$

26. $25^0 = 1$

28. $\dfrac{1}{-8^{-2}} = \dfrac{8^2}{-1} = -64$

30. $-\dfrac{1}{6^{-2}} = -6^2 = -36$

32. $\left(\dfrac{4}{5}\right)^{-3} = \left(\dfrac{5}{4}\right)^3 = \dfrac{125}{64}$

34. $\left(-\dfrac{5}{8}\right)^{-2} = \left(-\dfrac{8}{5}\right)^2 = \dfrac{64}{25}$

36. $4^2 \cdot 4^{-3} = 4^{2+(-3)} = 4^{-1} = \dfrac{1}{4}$

38. $\dfrac{5^{-1}}{5^2} = \dfrac{1}{5^{2-(-1)}} = \dfrac{1}{5^3} = \dfrac{1}{125}$

40. $\dfrac{10^{-5}}{10^{-6}} = 10^{-5-(-6)} = 10^{-1} = 10$

42. $(5^3 \cdot 5^{-4})^{-3} = (5^{3+(-4)})^{-3}$
$= (5^{-1})^{-3}$
$= 5^3$
$= 125$

44. $(-4^{-1})^{-2} = (-4)^2 = 16$

46. $4 - 3^{-2} = 4 - \dfrac{1}{3^2}$
$= 4 - \dfrac{1}{9}$
$= \dfrac{36}{9} - \dfrac{1}{9} = \dfrac{35}{9}$

48. $\left(\dfrac{1}{2} - \dfrac{2}{3}\right)^{-1} = \left(\dfrac{1(3)}{2(3)} - \dfrac{2(2)}{3(2)}\right)^{-1}$
$= \left(\dfrac{3}{6} - \dfrac{4}{6}\right)^{-1}$
$= \left(-\dfrac{1}{6}\right)^{-1}$
$= (-6)^1$
$= -6$

50. $(32 + 4^{-3})^0 = 1$

52. $x^{-2} \cdot x^{-5} = x^{-2+(-5)}$
$= x^{-7}$
$= \dfrac{1}{x^7}$

54. $t^{-1} \cdot t^{-6} = t^{-1+(-6)}$
$= t^{-7}$
$= \dfrac{1}{t^7}$

56. $3y^{-3} = \dfrac{3}{y^3}$

58. $(5u)^{-2} = \dfrac{1}{(5u)^2}$
$= \dfrac{1}{25u^2}$

60. $\dfrac{4}{y^{-1}} = 4y$

62. $\dfrac{6u^{-2}}{15u^{-1}} = \dfrac{2 \cdot 3}{3 \cdot 5u^{-1-(-2)}}$
$= \dfrac{2}{5u^1}$
$= \dfrac{2}{5u}$

64. $\dfrac{(5u)^{-4}}{(5u)^0} = (5u)^{-4-0}$
$= (5u)^{-4}$
$= \dfrac{1}{(5u)^4} = \dfrac{1}{625u^4}$

66. $(4a^{-2})^{-3} = 4^{-3}a^6$
$= \dfrac{a^6}{4^3} = \dfrac{a^6}{64}$

68. $(5s^5t^{-5})(-6s^{-2}t^4) = -30s^{5+(-2)}t^{(-5)+4} = -30s^3t^{-1}$
$= -\dfrac{30s^3}{t}$

70. $(-4y^{-3}z)^{-3} = \dfrac{1}{(-4y^{-3}z)^3} = \dfrac{1}{-64y^{-9}z^3}$
$= \dfrac{y^9}{-64z^3}$

72. $\left(\frac{4}{z}\right)^{-2} = \frac{4^{-2}}{z^{-2}} = \frac{z^2}{4^2} = \frac{z^2}{16}$

74. $\frac{2y^{-1}z^{-3}}{4yz^{-3}} = \frac{2z^3}{4yyz^3} = \frac{1z^{3-3}}{2y^2} = \frac{1z^0}{2y^2} = \frac{1}{2y^2}$

76. $\left(\frac{5^2x^3y^{-3}}{125xy}\right)^{-1} = \left(\frac{5^2x^{3-1}y^{-3-1}}{5^3}\right)^{-1} = \left(\frac{x^2y^{-4}}{5^{3-2}}\right)^{-1} = \left(\frac{x^2}{5y^4}\right)^{-1} = \frac{5y^4}{x^2}$

78. $\left(\frac{a^{-3}}{b^{-3}}\right)\left(\frac{b}{a}\right)^3 = \left(\frac{b^3}{a^3}\right)\left(\frac{b^3}{a^3}\right) = \frac{b^{3+3}}{a^{3+3}} = \frac{b^6}{a^6}$

80. $(ab)^{-2}(a^2b^2)^{-1} = a^{-2}b^{-2}a^{-2}b^{-2} = a^{-2+(-2)}b^{-2+(-2)} = a^{-4}b^{-4} = \frac{1}{a^4b^4}$

82. $x^5(3x^0y^4)(7y)^0 = x^5(3y^4)(1) = 3x^5y^4$

84. $[(2x^{-3}y^{-2})^2]^{-2} = [(2x^{-3}y^{-2})^{-4}] = 2^{-4}x^{12}y^8 = \frac{x^{12}y^8}{2^4} = \frac{x^{12}y^8}{16}$

86. $\frac{(5x^2y^{-5})^{-1}}{2x^{-5}y^4} = \frac{5^{-1}x^{-2}y^5}{2x^{-5}y^4} = \frac{x^{-2-(-5)}y^{5-4}}{5 \cdot 2} = \frac{x^3y}{10}$

88. $x^{-2}(x^2 + y^2) = x^{-2+2} + x^{-2}y^2 = x^0 + \frac{y^2}{x^2} = 1 + \frac{y^2}{x^2}$

90. $\frac{u^{-1} - v^{-1}}{u^{-1} + v^{-1}} = \frac{\frac{1}{u} - \frac{1}{v}}{\frac{1}{u} + \frac{1}{v}} = \frac{\frac{1}{u} - \frac{1}{v}}{\frac{1}{u} + \frac{1}{v}} \cdot \frac{uv}{uv} = \frac{v - u}{v + u}$

92. $98{,}100{,}000 = 9.81 \times 10^7$

94. $956{,}300{,}000 = 9.563 \times 10^8$

96. $0.00625 = 6.25 \times 10^{-3}$

98. $0.0007384 = 7.384 \times 10^{-4}$

100. $139{,}500{,}000 = 1.395 \times 10^8$

102. $0.0000001 = 1.0 \times 10^{-7}$

104. $0.00003937 = 3.937 \times 10^{-5}$

106. $5.05 \times 10^{12} = 5{,}050{,}000{,}000{,}000$

108. $8.6 \times 10^{-9} = 0.0000000086$

110. $3.5 \times 10^8 = 350{,}000{,}000$

112. $9.0 \times 10^{-9} = 0.000000009$

114. $9.0 \times 10^{-4} = 0.0009$

116. $(6.5 \times 10^6)(2 \times 10^4) = (6.5)(2) \times 10^{6+4} = 13.0 \times 10^{10} = 1.3 \times 10^{11}$

118. $(4 \times 10^6)^3 = 4^3 \times 10^{6 \cdot 3}$
$= 64 \times 10^{18}$
$= 6.4 \times 10^{19}$

120. $\dfrac{2.5 \times 10^{-3}}{5 \times 10^2} = 0.5 \times 10^{-3-2}$
$= 0.5 \times 10^{-5}$
$= 5.0 \times 10^{-6}$

122. $(62{,}000{,}000)(0.0002) = (6.2 \times 10^7)(2 \times 10^{-4})$
$= 12.4 \times 10^{7+(-4)}$
$= 12.4 \times 10^3$
$= 1.24 \times 10^4$

124. $\dfrac{72{,}000{,}000{,}000}{0.00012} = \dfrac{7.2 \times 10^{10}}{1.2 \times 10^{-4}}$
$= 6.0 \times 10^{10-(-4)}$
$= 6.0 \times 10^{14}$

126. $\dfrac{(3{,}450{,}000{,}000)(0.000125)}{(52{,}000{,}000)(0.000003)} = \dfrac{(3.45 \times 10^9)(1.25 \times 10^{-4})}{(5.2 \times 10^7)(3 \times 10^{-6})}$
$= \dfrac{(3.45 \times 1.25) \times 10^{9+(-4)}}{(5.2 \times 3) \times 10^{7+(-6)}}$
$= \dfrac{4.3125 \times 10^5}{15.6 \times 10^1}$
$\approx 0.276 \times 10^{5-1}$
$\approx 0.276 \times 10^4$
$\approx 2.76 \times 10^3$

128. $\dfrac{(3.82 \times 10^5)^2}{(8.5 \times 10^4)(5.2 \times 10^{-3})} = \dfrac{14.5924 \times 10^{10}}{44.2 \times 10^1}$
$\approx 0.3301447964 \times 10^9$
$\approx 3.301447964 \times 10^8$
$\approx 3.30 \times 10^8$

130. $(8.67 \times 10^4)^7 = (8.67)^7 \times 10^{28}$
$\approx 3682423.07 \times 10^{28}$
$\approx 3.68 \times 10^{34}$

132. $\dfrac{(6{,}200{,}000)(0.005)^3}{(0.00035)^5} = \dfrac{(6.2 \times 10^6)(5.0 \times 10^{-3})^3}{(3.5 \times 10^{-4})^5}$
$= \dfrac{(6.2 \times 10^6)(5.0)^3 \times 10^{-9}}{(3.5)^5 \times 10^{-20}}$
$= \dfrac{(6.2)(125) \times 10^{-3}}{(3.5)^5 \times 10^{-20}}$
$= \dfrac{(6.2)(125) \times 10^{-3-(-20)}}{(3.5)^5}$
$= \dfrac{(6.2)(125) \times 10^{17}}{(3.5)^5}$
$= \dfrac{775 \times 10^{17}}{525.21875}$
$\approx 1.48 \times 10^{17}$

134. $8.483 \times 10^{22} = 84{,}830{,}000{,}000{,}000{,}000{,}000{,}000$

136. $(95)(9.46 \times 10^{15}) = 899 \times 10^{15}$
$= 8.99 \times 10^{17}$ meters

138. $75(200)(1.1 \times 10^{-5}) = 16{,}500 \times 10^{-5} = 0.165$ foot

140. $\dfrac{58 \text{ million}}{6 \text{ billion}} = \dfrac{58{,}000{,}000}{6{,}000{,}000{,}000}$
$= \dfrac{5.8 \times 10^7}{6 \times 10^9}$
$= 0.966 \times 10^{-2}$
$= 9.66 \times 10^{-3}$ tons
$= 19\frac{1}{3}$ pounds

142. $(-2x)^{-4} = \dfrac{1}{(-2)^4x^4} = \dfrac{1}{16x^4}$ Both the -2 and x are raised to the -4 power.

$-2x^{-4} = -\dfrac{2}{x^4}$ Only the x is raised to the -4 power.

144. 32.5×10^5 is not in scientific notation because 32.5 is not in the interval $[1, 10)$.

Section 5.2 Adding and Subtracting Polynomials

2. Standard form: $t^5 - 14t^4 - 20t + 4$
Degree: 5
Leading coefficient: 1

4. Standard form: $-x + 50$
Degree: 1
Leading coefficient: -1

6. Standard form: $-y^2 + 4y + 12$
Degree: 2
Leading coefficient: -1

8. Standard form: $4t^5 - t^2 + 6t + 3$
Degree: 5
Leading coefficient: 4

10. Standard form: 28
Degree: 0
Leading coefficient: 28

12. Standard form: $-\frac{1}{2}at^2 + 48$
Degree: 2
Leading coefficient: $-\frac{1}{2}a$

14. $-6y + 3 + y^3$ is a trinomial

16. t^3 is a monomial

18. $25 - 2u^2$ is a binomial

20. A trinomial of degree 4 and leading coefficient of -2 is any trinomial beginning $-2x^4$ and containing two other terms of degree less than 4 such as $-2x^4 + 3x - 2$.

22. A monomial of degree 0 is any constant such as 16 or 8 or -4.

24. $x^3 - 4x^{1/3}$ is not a polynomial because the second term is not of the form ax^k (k must be a nonnegative integer).

26. $\dfrac{2}{x-4}$ is not a polynomial because the expression is not of the form ax^k.

28. $(6 - 2x) + 4x = 6 + (-2x + 4x) = 2x + 6$

30. $(3x + 1) + (6x - 1) = (3x + 6x) + (1-1) = 9x$

32. $(3x^3 - 2x + 8) + (3x - 5) = 3x^3 + (-2x + 3x) + (8 - 5) = 3x^3 + x + 3$

34. $(z^3 + 6z - 2) + (3z^2 - 6z) = z^3 + 3z^2 + (6z - 6z) + (-2)$
$= z^3 + 3z^2 - 2$

36. $(y^5 - 4y) + (3y - y^5) + (y^5 - 5) = (y^5 - y^5 + y^5) + (-4y + 3y) - 5$
$= y^5 - y - 5$

38. $(3a^2 + 5a) + (7 - a^2 - 5a) + (2a^2 + 8) = (3a^2 - a^2 + 2a^2) + (5a - 5a) + (7 + 8)$
$= 4a^2 + 15$

40. $\left(2 - \frac{1}{4}y^2 + y^4\right) + \left(\frac{1}{3}y^4 - \frac{3}{2}y^2 - 3\right) = \left(y^4 + \frac{1}{3}y^4\right) + \left(-\frac{1}{4}y^2 - \frac{3}{2}y^2\right) + (2 - 3)$
$= \left(\frac{3}{3}y^4 + \frac{1}{3}y^4\right) + \left(-\frac{1}{4}y^2 - \frac{6}{4}y^2\right) - 1$
$= \frac{4}{3}y^4 - \frac{7}{4}y^2 - 1$

42. $(0.13x^4 - 2.25x - 1.63) + (5.3x^4 + 1.76x^2 + 1.29x) =$
$(0.13x^4 + 5.3x^4) + 1.76x^2 + (-2.25x + 1.29x) - 1.63 =$
$5.43x^4 + 1.76x^2 - 0.96x - 1.63$

44.
$$\begin{array}{r} 3x^4 - 2x^2 - 9 \\ -5x^4 + x^2 \\ \hline -2x^4 - x^2 - 9 \end{array}$$

46.
$$\begin{array}{r} 4x^3 + 8x^2 - 5x + 3 \\ x^3 - 3x^2 \quad - 7 \\ \hline 5x^3 + 5x^2 - 5x - 4 \end{array}$$

48.
$$\begin{array}{r} -16t^2 + 48t + 64 \\ -32t + 16 \\ \hline -16t^2 + 16t + 80 \end{array}$$

50.
$$\begin{array}{r} 1.7y^3 - 6.2y^2 \quad + 5.9 \\ -3.5y^3 + 6.7y^2 + 2.2y \\ \hline -1.8y^3 + 0.5y^2 + 2.2y + 5.9 \end{array}$$

52. $(5y^4 - 2) - (3y^4 + 2) = (5y^4 - 2) + (-3y^4 - 2)$
$= (5y^4 - 3y^4) + (-2 + -2)$
$= 2y^4 - 4$

54. $(5q^2 - 3q + 5) - (4q^2 - 3q - 10) = (5q^2 - 3q + 5) + (-4q^2 + 3q + 10)$
$= (5q^2 - 4q^2) + (-3q + 3q) + (5 + 10)$
$= q^2 + 15$

56. $(-10s^2 - 5) - (2s^2 + 6s) = (-10s^2 - 5) + (-2s^2 - 6s)$
$= (-10s^2 - 2s^2) + (-6s) + (-5)$
$= -12s^2 - 6s - 5$

58. $\left(12 - \frac{2}{3}x + \frac{1}{2}x^2\right) - \left(x^3 + 3x^2 - \frac{1}{6}x\right) = \left(12 - \frac{2}{3}x + \frac{1}{2}x^2\right) + \left(-x^3 - 3x^2 + \frac{1}{6}x\right)$
$= 12 + \left(\frac{-2}{3}x + \frac{1}{6}x\right) + \left(\frac{+1}{2}x^2 - 3x^2\right) - x^3$
$= 12 + \left(\frac{-4}{6}x + \frac{1}{6}x\right) + \left(\frac{1}{2}x^2 - \frac{6}{2}x^2\right) - x^3$
$= 12 - \frac{3}{6}x - \frac{5}{2}x^2 - x^3$
$= 12 - \frac{1}{2}x - \frac{5}{2}x^2 - x^3$
$= -x^3 - \frac{5}{2}x^2 - \frac{1}{2}x + 12$

60. $(u^3 - 9.75u^2 + 0.12u - 3) - (0.7u^3 - 6.9u^2 - 4.83) = (u^3 - 9.75u^2 + 0.12u - 3) + (-0.7u^3 + 6.9u^2 + 4.83)$
$= (u^3 - 0.7u^3) + (-9.75u^2 + 6.9u^2) + 0.12u + (-3 + 4.83)$
$= 0.3u^3 - 2.85u^2 + 0.12u + 1.83$

62. $(y^2 + 3y^4) - (y^4 - (y^2 - 8y)) = (y^2 + 3y^4) + (-y^4 + (y^2 - 8y))$
$= (y^2 + y^2) + (3y^4 - y^4) - 8y$
$= 2y^4 + 2y^2 - 8y$

64.
$$\begin{array}{rl} & 3t^4 - 5t^2 \Longrightarrow 3t^4 - 5t^2 \\ \underline{-(-t^4 + 2t^2 - 14)} & \Longrightarrow \underline{\ t^4 - 2t^2 + 14\ } \\ & 4t^4 - 7t^2 + 14 \end{array}$$

66.
$$\begin{array}{rl} & 4x^2 + 5x - 6 \Longrightarrow \ 4x^2 + 5x - 6 \\ \underline{-(2x^2 - 4x + 5)} & \Longrightarrow \underline{-2x^2 + 4x - 5} \\ & 2x^2 + 9x - 11 \end{array}$$

68.
$$\begin{array}{rl} & (13x^3 - 9x^2 + 4x - 5) \ - \ (5x^3 + 7x + 3) \\ & 13x^3 - 9x^2 + 4x - 5) \Longrightarrow \ 13x^3 - 9x^2 + 4x - 5 \\ \underline{-(5x^3 \quad + 7x + 3)} & \Longrightarrow \underline{-5x^3 \quad - 7x - 3} \\ & 8x^3 - 9x^2 - 3x - 8 \end{array}$$

70. $(2x^2 + 1) - (x^2 - 2x + 1) = (2x^2 + 1) + (-x^2 + 2x - 1)$
$= (2x^2 - x^2) + 2x + (1-1)$
$= x^2 + 2x$

72. $(15 - 2y + y^2) + (3y^2 - 6y + 1) - (4y^2 - 8y + 16) = (y^2 + 3y^2 - 4y^2) + (-2y - 6y + 8y) + (15 + 1 - 16)$
$= 0$

74. $(p^3 + 4) - [(p^2 + 4) + (3p - 9)] = (p^3 + 4) - [p^2 + 3p + (4 - 9)]$
$= (p^3 + 4) - [p^2 + 3p - 5]$
$= (p^3 + 4) + (-p^2 - 3p + 5)$
$= p^3 - p^2 - 3p + (4 + 5)$
$= p^3 - p^2 - 3p + 9$

76. $(5x^4 - 3x^2 + 9) - [(2x^4 + x^3 - 7x^2) - (x^2 + 6)] = (5x^4 - 3x^2 + 9) + (-2x^4 - x^3 + 7x^2 + x^2 + 6)$
$= (5x^4 - 2x^4) - x^3 + (-3x^2 + 7x^2 + x^2) + (9 + 6)$
$= 3x^4 - x^3 + 5x^2 + 15$

78. $(x^3 - 2x^2 - x) - 5(2x^3 + x^2 - 4x) = (x^3 - 2x^2 - x) - 10x^3 - 5x^2 + 20x$
$= (x^3 - 10x^3) + (-2x^2 - 5x^2) + (-x + 20x)$
$= -9x^3 - 7x^2 + 19x$

80. $-10(v + 2) + 8(v - 1) - 3(v - 9) = -10v - 20 + 8v - 8 - 3v + 27$
$= (-10v + 8v - 3v) + (-20 - 8 + 27)$
$= -5v - 1$

82. $9(7x^2 - 3x + 3) - 4(15x + 2) - (3x^2 - 7x) = 63x^2 - 27x + 27 - 60x - 8 - 3x^2 + 7x$
$= (63x^2 - 3x^2) + (-27x - 60x + 7x) + (27 - 8)$
$= 60x^2 - 80x + 19$

84. $3x^2 - 2[3x + (9 - x^2)] = 3x^2 - 2[3x + 9 - x^2]$
$= 3x^2 - 6x - 18 + 2x^2$
$= (3x^2 + 2x^2) - 6x - 18$
$= 5x^2 - 6x - 18$

86. $(6x^{2r} - 5x^r + 4) + (2x^{2r} + 2x^r + 3) = (6x^{2r} + 2x^{2r}) + (-5x^r + 2x^r) + (4 + 3)$

$= 8x^{2r} - 3x^r + 7$

88. $(x^{2m} - 6x^m + 4) - (2x^{2m} - 4x^m - 3) = (x^{2m} - 6x^m + 4) + (-2x^{2m} + 4x^m + 3)$

$= (x^{2m} - 2x^{2m}) + (-6x^m + 4x^m) + (4 + 3)$

$= -x^{2m} - 2x^m + 7$

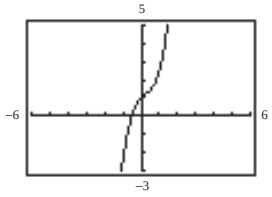
90. $(-4x^{3n} + 5x^{2n} + x^n) - (x^{2n} + 9x^n - 14) = (-4x^{3n} + 5x^{2n} + x^n) + (-x^{2n} - 9x^n + 14)$

$= (-4x^{3n}) + (5x^{2n} - x^{2n}) + (x^n - 9x^n) + 14$

$= -4x^{3n} + 4x^{2n} - 8x^n + 14$

92. y_1 [Y=] [(] [(] 1 [÷] 2 [)] [X,T,θ] [^] 3 [+] 2 [X,T,θ] [)] [+] [(] [X,T,θ] [^] 3 [−] [X,T,θ] [x²] [−] [X,T,θ] [+] 1 [)] [ENTER]

y_2 [(] 3 [÷] 2 [)] [X,T,θ] [^] 3 [−] [X,T,θ] [x²] [+] [X,T,θ] [+] 1 [GRAPH]



y_1 and y_2 represent equivalent expressions since the graphs of y_1 and y_2 are identical.

94. $h(x) = f(x) - g(x)$

$= (4x^3 - 3x^2 + 7) - (9 - x - x^2 - 5x^3)$

$= (4x^3 - 3x^2 + 7) + (-9 + x + x^2 + 5x^3)$

$= (4x^3 + 5x^3) + (-3x^2 + x^2) + x + (7 - 9)$

$= 9x^3 - 2x^2 + x - 2$

96.

Polynomial	***Value***	***Substitute***	***Simplify***
$h(t) = -16t^2 + 256$	$(a)t = 0$	$-16(0)^2 + 256$	256 feet
	$(b)t = 1$	$-16(1)^2 + 256$	240 feet
	$(c)t = \frac{5}{2}$	$-16\left(\frac{5}{2}\right)^2 + 256$	156 feet
	$(d)t = 4$	$-16(4)^2 + 256$	0 feet

At time $t = 0$, the object is dropped from a height of 256 feet and continues to fall, reaching the ground at time $t = 4$.

98.

Polynomial	***Value***	***Substitute***	***Simplify***
$h(t) = -16t^2 + 96t$	$(a)t = 0$	$-16(0)^2 + 96(0)$	0 feet
	$(b)t = 2$	$-16(2)^2 + 96(2)$	128 feet
	$(c)t = 3$	$-16(3)^2 + 96(3)$	144 feet
	$(d)t = 6$	$-16(6)^2 + 96(6)$	0 feet

At $t = 0$, the object is projected upward from a height of 0 feet (on the ground), reaches a maximum height, and returns downward. At time $t = 6$, the object is again on the ground.

100. The free-falling object was thrown upward.

$h(t) = -16(0)^2 + 50(0)$

$h(0) = 0 + 0$

$h(0) = 0$ feet

102. The free-falling object was thrown upward.

$h(0) = -16(0)^2 + 32(0) + 300$

$h(0) = 0 + 0 + 300$

$h(0) = 300$ feet

104. $h(t) = -16t^2 + 200$

$h(1) = -16(1)^2 + 200 = -16 + 200 = 184$ feet

$h(2) = -16(2)^2 + 200 = -16(4) + 200 = -64 + 200 = 136$ feet

$h(3) = -16(3)^2 + 200 = -16(9) + 200 = -144 + 200 = 56$ feet

106. *Verbal Model:* $\boxed{\text{Profit}} = \boxed{\text{Revenue}} - \boxed{\text{Cost}}$

Equation: $P = R - C$

$P = 17x - (12x + 8000)$

$P = 5x - 8000$

$P = 5(10{,}000) - 8000$

$P = \$42{,}000$

108. Perimeter $= (4x + 2) + (2x + 10) + (2x - 5) + (x + 3) + 2x + 4x$

$= 15x + 10$

110. Area of Region $= 5 \cdot x + 5 \cdot x + 5 \cdot 3x$ or $5 \cdot [x + x + 3x]$

$= 5x + 5x + 15x$ or $5[5x]$

$= 25x$ or $25x$

112. Area $= (4x + 7)5 - 2x(4)$

$= 20x + 35 - 8x$

$= 12x + 35$

114. (a) *Verbal Model:* $\boxed{\text{Per capita consumption of milk and coffee}} = \boxed{\text{Per capita consumption of milk}} - \boxed{\text{Per capita consumption of coffee}}$

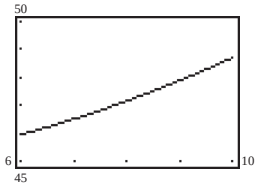
Equation: $y = (-0.33t + 25.9) + (0.043t^2 + 0.33t + 18.5)$

$y = (0.043t^2) + (-0.33t + 0.33t) + (25.9 + 18.5)$

$y = 0.043t^2 + 44.4$

(b) *Keystrokes:*

$\boxed{Y=}$ 0.043 $\boxed{X,T,\theta}$ $\boxed{x^2}$ $\boxed{+}$ 44.4 $\boxed{\text{GRAPH}}$



Consumption was increasing over the interval $6 \le t \le 10$.

116. Addition (or subtraction) separates terms.
Multiplication separates factors.

118. Yes, two third-degree polynomials can be added to produce a second-degree polynomial. For example,
$(x^3 - 2x^2 + 4) + (-x^3 + x^2 + 3x) = -x^2 + 3x + 4$

120. To subtract one polynomial from another, add the opposite. You can do this by changing the sign of each of the terms of the polynomial that is being subtracted and the adding the resulting like terms.

Section 5.3 Multiplying Polynomials

2. $(-6n)(3n^2) = (-6 \cdot 3)(n \cdot n^2) = -18n^{1+2} = -18n^3$

4. $5z(2z - 7) = 5z(2z) + 5z(-7) = 10z^2 - 35z$

6. $3y(-3y^2 + 7y - 3) = 3y(-3y^2) + 3y(7y) + 3y(-3)$
$= -9y^3 + 21y^2 - 9y$

8. $-3a^2(8 - 2a - a^2) = -3a^2(8) - 3a^2(-2a) - 3a^2(-a^2)$
$= 3a^4 + 6a^3 - 24a^2$

10. $-y^4(7y^3 - 4y^2 + y - 4) = -7y^7 + 4y^6 - y^5 + 4y^4$

12. $4t(-3t)(t^2 - 1) = (-12t^2)(t^2 - 1)$
$= (-12t^2)(t^2) - (-12t^2)(1)$
$= -12t^4 + 12t^2$

14. $ab^3(2a - 9a^2b + 3b) = ab^3(2a) + ab^3(-9a^2b) + ab^3(3b)$
$= 2a^2b^3 - 9a^3b^4 + 3ab^4$

16. $(x - 5)(x - 3) = x^2 - 3x - 5x + 15 = x^2 - 8x + 15$

18. $(x + 7)(x - 1) = x^2 - x + 7x - 7 = x^2 + 6x - 7$

20. $(x - 6)(x + 6) = x^2 + 6x - 6x - 36 = x^2 - 36$

22. $(3x + 1)(x - 4) = 3x^2 - 12x + x - 4 = 3x^2 - 11x - 4$

24. $(4x + 7)(3x + 7) = 12x^2 + 28x + 21x + 49 = 12x^2 + 49x + 49$

26. $(6x^2 + 2)(9 - 2x) = 54x^2 - 12x^3 + 18 - 4x = -12x^3 + 54x^2 - 4x + 18$

28. $\left(5t - \frac{3}{4}\right)(2t - 16) = 10t^2 - 80t - \frac{3}{2}t + 12$
$= 10t^2 - \frac{160}{2}t - \frac{3}{2}t + 12$
$= 10t^2 - \frac{163}{2}t + 12$

30. $(2x - y)(3x - 2y) = 6x^2 - 4xy - 3xy + 2y^2$
$= 6x^2 - 7xy + 2y^2$

32. $(s - 3t)(s + t) - (s - 3t)(s - t) = s^2 + st - 3ts - 3t^2 - s^2 + st + 3ts - 3t^2$
$= 2st - 6t^2$

34. $(z + 2)(z^2 - 4z + 4) = (z + 2)z^2 + (z + 2)(-4z) + (z + 2)4$
$= z^3 + 2z^2 - 4z^2 - 8z + 4z + 8$
$= z^3 - 2z^2 - 4z + 8$

36. $(2t + 3)(t^2 - 5t + 1) = (2t + 3)t^2 + (2t + 3)(-5t) + (2t + 3)(1)$
$= 2t^3 + 3t^2 - 10t^2 - 15t + 2t + 3$
$= 2t^3 - 7t^2 - 13t + 3$

38. $(2x^2 - 5x + 1)(3x - 4) = (3x - 4)2x^2 + (3x - 4)(-5x) + (3x - 4)1$
$= 6x^3 - 8x^2 - 15x^2 + 20x + 3x - 4$
$= 6x^3 - 23x^2 + 23x - 4$

40. $(x^2 + 4)(x^2 - 2x - 4) = (x^2 + 4)x^2 + (x^2 + 4)(-2x) + (x^2 + 4)(-4)$
$= x^2 \cdot x^2 + 4x^2 - x^2(2x) - 8x - 4x^2 - 16$
$= x^4 + 4x^2 - 2x^3 - 8x - 4x^2 - 16$
$= x^4 - 2x^3 - 8x - 16$

42. $(2x^2 - 3)(2x^2 - 2x + 3) = (2x^2 - 3)(2x^2) + (2x^2 - 3)(-2x) + (2x^2 - 3)(3)$
$= 4x^4 - 6x^2 - 4x^3 + 6x + 6x^2 - 9$
$= 4x^4 - 4x^3 + 6x - 9$

44. $(y^2 + 3y + 5)(2y^2 - 3y - 1) = y^2(2y^2 - 3y - 1) + 3y(2y^2 - 3y - 1) + 5(2y^2 - 3y - 1)$
$= 2y^4 - 3y^3 - y^2 + 6y^3 - 9y^2 - 3y + 10y^2 - 15y - 5$
$= 2y^4 + 3y^3 - 18y - 5$

46.
$$\begin{array}{r} 4x^4 - 6x^2 + 9 \\ \times \quad 2x^2 + 3 \\ \hline + 12x^4 - 18x^2 + 27 \\ 8x^6 - 12x^4 + 18x^2 \\ \hline 8x^6 \qquad\qquad + 27 \end{array}$$

48.
$$\begin{array}{r} z^2 + z + 1 \\ \times \quad z - 2 \\ \hline - 2z^2 - 2z - 2 \\ z^3 + z^2 + z \\ \hline z^3 - z^2 - z - 2 \end{array}$$

50.
$$\begin{array}{r} 2s^2 - 5s + 6 \\ \times \quad 3s - 4 \\ \hline - 8s^2 + 20s - 24 \\ 6s^3 - 15s^2 + 18s \\ \hline 6s^3 - 23s^2 + 38s - 24 \end{array}$$

52.
$$\begin{array}{r} y^2 + 3y + 5 \\ 2y^2 - 3y - 1 \\ \hline - y^2 - 3y - 5 \\ - 3y^3 - 9y^2 - 15y \\ 2y^4 + 6y^3 + 10y^2 \\ \hline 2y^4 + 3y^3 \qquad - 18y - 5 \end{array}$$

54. $(x - 5)(x + 5) = (x)^2 - (5)^2 = x^2 - 25$

56. $(x + 1)(x - 1) = (x)^2 - (1)^2 = x^2 - 1$

58. $(4 + 3z)(4 - 3z) = (4)^2 - (3z)^2 = 16 - 9z^2$

60. $(8 - 3x)(8 + 3x) = (8)^2 - (3x)^2 = 64 - 9x^2$

62. $(5u + 12v)(5u - 12v) = (5u)^2 - (12v)^2$
$= 25u^2 - 144v^2$

64. $(8x - 5y)(8x + 5y) = (8x)^2 - (5y)^2$
$= 64x^2 - 25y^2$

66. $\left(\frac{2}{3}x + 7\right)\left(\frac{2}{3}x - 7\right) = \left(\frac{2}{3}x\right)^2 - (7)^2 = \frac{4}{9}x^2 - 49$

68. $(4a - 0.1b)(4a + 0.1b) = (4a)^2 - (0.1b)^2$
$= 16a^2 - 0.01b^2$

70. $(x + 2)^2 = (x)^2 + 2(x)(2) + (2)^2 = x^2 + 4x + 4$

72. $(u - 7)^2 = (u)^2 - 2(u)(7) + (7)^2 = u^2 - 14u + 49$

74. $(3x + 8)^2 = (3x)^2 + 2(3x)(8) + (8)^2 = 9x^2 + 48x + 64$

76. $(5 - 3z)^2 = (5)^2 - 2(5)(3z) + (3z)^2 = 25 - 30z + 9z^2$

78. $(3m + 4n)^2 = (3m)^2 + 2(3m)(4n) + (4n)^2$
$= 9m^2 + 24mn + 16n^2$

80. $[(x - 4) - y]^2 = (x - 4)^2 - 2(x - 4)(y) + (y)^2$
$= (x)^2 - 2(x)(4) + (4)^2 - 2xy + 8y + y^2$
$= x^2 - 8x + 16 - 2xy + 8y + y^2$ or
$x^2 - 2xy + y^2 - 8x + 8y + 16$

82. $[z + (y + 1)][z - (y + 1)] = (z)^2 - (y + 1)^2$
$= z^2 - ((y)^2 + 2(y)(1) + 1^2)$
$= z^2 - (y^2 + 2y + 1)$
$= z^2 - y^2 - 2y - 1$

84. $(y - 2)^3 = (y - 2)(y - 2)(y - 2)$
$= (y^2 - 4y + 4)(y - 2)$
$= y^2(y - 2) - 4y(y - 2) + 4(y - 2)$
$= y^3 - 2y^2 - 4y^2 + 8y + 4y - 8$
$= y^3 - 6y^2 + 12y - 8$

86. $(u - v)^3 = (u - v)(u - v)(u - v)$
$= (u^2 - 2uv + v^2)(u - v)$
$= u^2(u - v) - 2uv(u - v) + v^2(u - v)$
$= u^3 - u^2v - 2u^2v + 2uv^2 + uv^2 - v^3$
$= u^3 - 3u^2v + 3uv^2 - v^3$

88. $5x^r(4x^{r+2} - 3x^r) = 5x^r(4x^{r+2}) - 5x^r(3x^r)$
$= 20x^{r+r+2} - 15x^{r+r}$
$= 20x^{2r+2} - 15x^{2r}$

90. $(x^{3m} - x^{2m})(x^{2m} + 2x^{4m}) = x^{3m}(x^{2m} + 2x^{4m}) + -x^{2m}(x^{2m} + 2x^{4m})$
$= x^{3m+2m} + 2x^{3m+4m} - x^{2m+2m} - 2x^{2m+4m}$
$= x^{5m} + 2x^{7m} - x^{4m} - 2x^{6m}$
$= 2x^{7m} - 2x^{6m} + x^{5m} - x^{4m}$

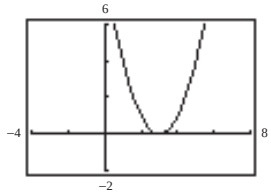
92. $(y^{m+n})^{m+n} = y^{(m+n)(m+n)}$
$= y^{m^2+2(m)(n)+n^2}$
$= y^{m^2+2mn+n^2}$

94. *Keystrokes:*

y_1 Y= (X,T,θ) − 3) x^2 ENTER

y_2 X,T,θ x^2 − 6 X,T,θ + 9 GRAPH

$y_1 = y_2$ because $(x - 3)^2 = (x)^2 - 2(x)(3) + (3)^2 = x^2 + 6x - 9$

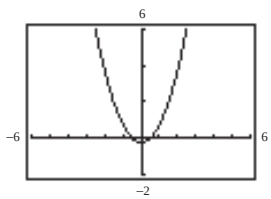


96. *Keystrokes:*

y_1 Y= (X,T,θ + (1 ÷ 2)) (X,T,θ − (1 ÷ 2)) ENTER

y_2 X,T,θ x^2 − (1 ÷ 4) GRAPH

$y_1 = y_2$ because $\left(x + \frac{1}{2}\right)\left(x - \frac{1}{2}\right) = (x)^2 - \left(\frac{1}{2}\right)^2 = x^2 - \frac{1}{4}$



98. (a) $f(y+2) = 2(y+2)^2 - 5(y+2) + 4$

$= 2(y^2 + 4y + 4) - 5y - 10 + 4$

$= 2y^2 + 8y + 8 - 5y - 10 + 4$

$= 2y^2 + 3y + 2$

(b) $f(1+h) - f(1) = 2(1+h)^2 - 5(1+h) + 4 - [2(1)^2 - 5(1) + 4]$

$= 2(1 + 2h + h^2) - 5 - 5h + 4 - [2 - 5 + 4]$

$= 2 + 4h + 2h^2 - 5 - 5h + 4 - (1)$

$= 2h^2 - h$

100. (a) *Verbal Model:* $\boxed{\text{Volume}} = \boxed{\text{Length}} \cdot \boxed{\text{Width}} \cdot \boxed{\text{Height}}$

Function: $V(n) = (2n-2) \cdot (2n+2) \cdot (2n)$

$= (4n^2 - 4)(2n)$

$= 8n^3 - 8n$

(b) $2n - 2 = 6$, $n = 4$, $V(4) = 8(4)^3 - 8(4)$

$= 8(64) - 32$

$= 512 - 32$

$= 480$ cubic inches

(c) *Verbal Model:* $\boxed{\text{Area}} = \boxed{\text{Length}} \cdot \boxed{\text{Width}}$

Function: $A(n) = (2n+2) \cdot (2n-2)$

$= 4n^2 - 4$

(d) *Area* $= (2n + 2 + 2)(2n - 2 + 2)$

$= (2n + 4)(2n)$

$= 4n^2 + 8n$

$A(n+4) = (2(n+4) + 2) \cdot (2(n+4) - 2)$

$= (2n + 8 + 2)(2n + 8 - 2)$

$= (2n + 10)(2n + 6)$

$= 4n^2 + 12n + 20n + 60$

$= 4n^2 + 32n + 60$

102. *Verbal Model:* $\boxed{\begin{array}{c}\text{Area of}\\ \text{Shaded}\\ \text{Region}\end{array}} = \boxed{\begin{array}{c}\text{Area of}\\ \text{Outside}\\ \text{Rectangle}\end{array}} - \boxed{\begin{array}{c}\text{Area of}\\ \text{Inside}\\ \text{Rectangle}\end{array}}$

Equation: $A = l \cdot w - l \cdot w$

$A = 3x \cdot x - (x-3)2$

$A = 3x^2 - 2x + 6$

104. *Verbal Model:* $\boxed{\begin{array}{c}\text{Area of}\\ \text{shaded region}\end{array}} = \boxed{\begin{array}{c}\text{Area of}\\ \text{rectangle}\end{array}} - \boxed{\begin{array}{c}\text{Area of}\\ \text{triangle}\end{array}}$

Equation: $A = (x+5)(x+2x) - \frac{1}{2}(x)(x+5)$

$= (x+5)(3x) - \frac{1}{2}x(x+5)$

$= 3x^2 + 15x - \frac{1}{2}x^2 - \frac{5}{2}x$

$= \frac{5}{2}x^2 + \frac{25}{2}x$

106. $A = \frac{1}{2}b \cdot h$

$= \frac{1}{2}(3x)(x+5)$

$= \frac{3}{2}x(x+5)$

$= \frac{3}{2}x^2 + \frac{15}{2}x$

108. *Verbal Model:* Revenue = (Number of units sold) · (Price per unit)

Equation: $R = x \cdot p$

$= x(20 - 0.015x)$

$= 20x - 0.015x^2$

$R = -0.015x^2 + 20x$

$R = -0.015(50)^2 + 20(50)$

$= \$962.50$

110. Interest $= 1000(1 + 0.095)^2$

$= 1000(1.095)^2$

$= 1000(1.199025)$

$= 1199.025$

$\approx \$1199.03$

112. Area $= l \cdot w$

$= (x + a)(x + a)$

$= x^2 + 2ax + a^2$

Area $= (x \cdot x) + (a \cdot x) + (a \cdot x) + (a \cdot a)$

$= x^2 + ax + ax + a^2$

$= x^2 + 2ax + a^2$

Formula $= (x + a)(x + a) = x^2 + 2ax + a^2$

Square of a binomial

114. (a) $(x + y)^2 = (x + y)(x + y)$

$= x^2 + xy + yx + y^2$

$= x^2 + 2xy + y^2$

(b) $(x - y)^2 = (x - y)(x - y)$

$= x^2 - xy - xy + y^2$

$= x^2 - 2xy + y^2$

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

$= x^2 - y^2$

116. Example: $(x + 2)(x - 3) = x(x - 3) + 2(x - 3)$

$= x^2 - 3x + 2x - 6$

$= x^2 - x - 6$

118. The degree of the product of two polynomials of degrees m and n is $m + n$.

Section 5.4 Factoring by Grouping and Special Forms

2. $36 = 2^2 \cdot 3^2$

$150 = 2 \cdot 3 \cdot 5^2$

$100 = 2^2 \cdot 5^2$

GCF $= 2$

4. $27x^4 = 3^3x^4$

$18x^3 = 2 \cdot 3^2x^3$

GCF $= 9x^3$

6. $-45y = (-1) \cdot 3^2 \cdot 5 \cdot y$

$150y^3 = 2 \cdot 3 \cdot 5^2 \cdot y^3$

GCF $= 3 \cdot 5 \cdot y = 15y$

8. $16x^2y = 2^4x^2y$

$84xy^2 = 2^2 \cdot 3 \cdot 7 \cdot x \cdot y^2$

$36x^2y^2 = 2^2 \cdot 3^2 \cdot x^2 \cdot y^2$

GCF $= 2^2 \cdot x \cdot y = 4xy$

10. $66(3 - y) = 2 \cdot 3 \cdot 11 \cdot (3 - y)$

$44(3 - y)^2 = 2^2 \cdot 11 \cdot (3 - y)^2$

GCF $= 2 \cdot 11 \cdot (3 - y) = 22(3 - y)$

12. $7y - 7 = 7(y - 1)$

14. $9x + 30 = 3(3x + 10)$

16. $54x^2 - 36 = 18(3x^2 - 2)$

18. $y^2 - 5y = y(y - 5)$

20. $3x^2 + 6x = 3x(x + 2)$

22. $16 - 3y^3$ is prime.
No common factor other than 1.

24. $9 - 27y - 15y^2 = 3(3 - 9y - 5y^2)$

26. $4uv + 6u^2v^2 = 2uv(2 + 3uv)$

28. $4x^2 - 2xy + 3y^2$ Prime
No common factor other than 1.

30. $17x^5y^3 - xy^2 + 34y^2 = y^2(17x^5y - x + 34)$

32. $4 - x^3 = -(-4 + x^3) = -(x^3 - 4)$

34. $15 - 5x = -5(-3 + x) = -5(x - 3)$

36. $12x - 6x^2 - 18 = -6(-2x + x^2 + 3)$
$= -6(x^2 - 2x + 3)$

38. $-2t^3 + 4t^2 + 7 = -1(2t^3 - 4t^2 - 7)$
$= -(2t^3 - 4t^2 - 7)$

40. $3z + \frac{3}{8} = \frac{1}{8}(24z + 3)$

42. $\frac{1}{3}x - \frac{5}{6} = \frac{1}{6}(2x - 5)$

44. $7t(s + 9) - 6(s + 9) = (s + 9)(7t - 6)$

46. $6(4t - 3) - 5t(4t - 3) = (4t - 3)(6 - 5t)$

48. $4(5y - 12) + 3y^2(5y - 12) = (5y - 12)(4 + 3y^2)$

50. $2y^2(y^2 + 6)^3 + 7(y^2 + 6)^3 = (y^2 + 6)^3(2y^2 + 7)$

52. $(3x + 7)(2x - 1) + (x - 6)(2x - 1) = (2x - 1)(3x + 7 + x - 6)$
$= (2x - 1)(4x + 1)$

54. $x^2 - 9x + x - 9 = (x^2 - 9x) + (x - 9)$
$= x(x - 9) + (x - 9)$
$= (x - 9)(x + 1)$

56. $y^2 + 3y + 4y + 12 = (y^2 + 3y) + (4y + 12)$
$= y(y + 3) + 4(y + 3)$
$= (y + 3)(y + 4)$

58. $t^3 - 11t^2 + t - 11 = (t^3 - 11t^2) + (t - 11)$
$= t^2(t - 11) + (t - 11)$
$= (t - 11)(t^2 + 1)$

60. $3s^3 + 6s^2 + 5s + 10 = (3s^3 + 6s^2) + (5s + 10)$
$= 3s^2(s + 2) + 5(s + 2)$
$= (s + 2)(3s^2 + 5)$

62. $4u^4 - 6u - 2u^3 + 3 = (4u^4 - 6u) + (-2u^3 + 3)$
$= 2u(2u^3 - 3) - 1(2u^3 - 3)$
$= (2u^3 - 3)(2u - 1)$

64. $10u^4 - 8u^2v^3 - 12v^4 + 15u^2v = (10u^4 - 8u^2v^3) + (-12v^4 + 15u^2v)$
$= 2u^2(5u^2 - 4v^3) + 3v(-4v^3 + 5u^2)$
$= (5u^2 - 4v^3)(2u^2 + 3v)$

66. $y^2 - 144 = y^2 - (12)^2$
$= (y - 12)(y + 12)$

68. $16 - b^2 = 4^2 - b^2$
$= (4 - b)(4 + b)$

70. $9z^2 - 36 = (3z)^2 - (6)^2$
$= (3z - 6)(3z + 6)$
$= 3(z - 2)3(z + 2)$
$= 9(z - 2)(z + 2)$

72. $49 - 64x^2 = 7^2 - (8x)^2$
$= (7 - 8x)(7 + 8x)$

74. $9u^2 - v^2 = (3u)^2 - (v)^2$
$= (3u - v)(3u + v)$

76. $100a^2 - 49b^2 = (10a)^2 - (7b)^2$
$= (10a - 7b)(10a + 7b)$

78. $v^2 - \frac{9}{25} = v^2 - \left(\frac{3}{5}\right)^2$
$= \left(v - \frac{3}{5}\right)\left(v + \frac{3}{5}\right)$

80. $\frac{1}{4}x^2 - \frac{36}{49}y^2 = \left(\frac{1}{2}x\right)^2 - \left(\frac{6}{7}y\right)^2$
$= \left(\frac{1}{2}x - \frac{6}{7}y\right)\left(\frac{1}{2}x + \frac{6}{7}y\right)$

82. $(x-3)^2 - 4 = (x-3)^2 - (2)^2$
$= [(x-3) - 2][(x-3) + 2]$
$= (x-5)(x-1)$

84. $36 - (y-6)^2 = (6)^2 - (y-6)^2$
$= [6 - (y-6)][6 + (y-6)]$
$= [6 - y + 6][6 + y - 6]$
$= [-y + 12][y]$
$= y(12 - y)$

86. $(3y-1)^2 - (x+6)^2 = [(3y-1) - (x+6)][(3y-1) + (x+6)]$
$= [3y - 1 - x - 6][3y - 1 + x + 6]$
$= (3y - x - 7)(3y + x + 5)$
or
$= -(x - 3y + 7)(x + 3y + 5)$

88. $t^3 - 1 = t^3 - (1)^3$
$= (t-1)(t^2 + t + 1)$

90. $z^3 + 125 = z^3 + 5^3$
$= (z+5)(z^2 - 5z + 25)$

92. $27s^3 + 64 = (3s)^3 + (4)^3$
$= (3s + 4)(9s^2 - 12s + 16)$

94. $64v^3 - 125 = (4v)^3 - (5)^3$
$= (4v - 5)(16v^2 + 20v + 25)$

96. $m^3 - 8n^3 = m^3 - (2n)^3$
$= (m - 2n)(m^2 + 2mn + 4n^2)$

98. $u^3 + 125v^3 = u^3 + (5v)^3$
$= (u + 5v)(u^2 - 5uv + 25v^2)$

100. $8y^2 - 18 = 2(4y^2 - 9)$
$= 2((2y)^2 - 3^2)$
$= 2(2y - 3)(2y + 3)$

102. $a^3 - 16a = a(a^2 - 16)$
$= a[a^2 - (4)^2]$
$= a(a-4)(a+4)$

104. $u^4 - 16 = (u^2)^2 - (4)^2$
$= (u^2 - 4)(u^2 + 4)$
$= [(u^2 - (2)^2][u^2 + 4]$
$= (u - 2)(u + 2)(u^2 + 4)$

106. $6x^5 + 30x^3 = 6x^3(x^2 + 5)$

108. $2u^6 + 54v^6 = 2(u^6 + 27v^6)$
$= 2[(u^2)^3 + (3v^2)^3]$
$= 2(u^2 + 3v^2)(u^4 - 3u^2v^2 + 9v^4)$

110. $81 - 16y^{4n} = 9^2 - (4y^{2n})^2$
$= (9 - 4y^{2n})(9 + 4y^{2n})$
$= [3^2 - (2y^n)^2](9 + 4y^{2n})$
$= (3 - 2y^n)(3 + 2y^n)(9 + 4y^{2n})$

112. $3x^{n+1} + 6x^n - 15x^{n+2} = -3x^n(-x - 2 + 5x^2)$
$= -3x^n(5x^2 - x - 2)$

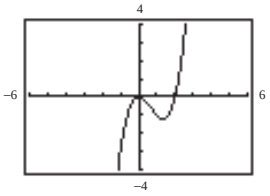
114. $x^{2r+s} - 5x^{r+3s} + 10x^{2r+2s} = x^{r+s}(x^r - 5x^{2s} + 10x^{r+s})$
$= x^{r+s}(10x^{r+s} - 5x^{2s} + x^r)$

116. *Keystrokes:*

y_1 [Y=] [X,T,θ] [^] 3 [−] 2 [X,T,θ] [x^2] [ENTER]

y_2 [X,T,θ] [x^2] [(] [X,T,θ] [−] 2 [)] [GRAPH]

$y_1 = y_2$

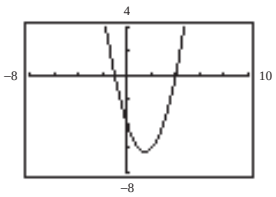


118. *Keystrokes:*

y_1 [Y=] [X,T,θ] [(] [X,T,θ] [+] 1 [)] [−] 4 [(] [X,T,θ] [+] 1 [)] [ENTER]

y_2 [(] [X,T,θ] [+] 1 [)] [(] [X,T,θ] [−] 4 [)] [GRAPH]

$y_1 = y_2$



120. $6x^3 - 8x^2 + 9x - 12 = (6x^3 - 8x^2) + (9x - 12)$

$= 2x^2(3x - 4) + 3(3x - 4)$

$= (3x - 4)(2x^2 + 3)$

or $6x^3 - 8x^2 + 9x - 12 = (6x^3 + 9x) + (-8x^2 - 12)$

$= 3x(2x^2 + 3) - 4(2x^2 + 3)$

$= (2x^2 + 3)(3x - 4)$

122. $R = 1000x - 0.4x^2$

$= x(1000 - 0.4x)$

$R = xp$

$p = 1000 - 0.4x$

124. $kQx - kx^2 = kx(Q - x)$

126. $A = 32w - w^2$

$= w(32 - w)$

$= w \cdot l$

Thus, $l = 32 - w$

128. $S = \pi r^2 + 2\pi rh$

$= \pi r(r + 2h)$

130. (a)

Solid	Length	Width	Height	Volume
Entire cube	a	a	a	a^3
Solid I	a	a	$a - b$	$a^2(a - b)$
Solid II	a	$a - b$	b	$ab(a - b)$
Solid III	$a - b$	b	b	$b^2(a - b)$
Solid IV	b	b	b	b^3

(b) Solid I + Solid II + Solid III

$a^2(a - b) + ab(a - b) + b^2(a - b) = (a - b)(a^2 + ab + b^2)$

(c) If the smaller cube is removed from the larger, the remaining solid has a volume of $a^3 - b^3$ and is composed of the three rectangular boxes labeled solid I, solid II, and solid III. From part (b) we have $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$.

132. Check a result after factoring by multiplying the factors to see if the product is the original polynomial.

134. Factor used as a noun expresses any one of the expressions that when multiplied together yields the product.

Factor used as a verb is the process of finding the expressions that, when multiplied together, yield the given product.

136. An example of a polynomial that is prime with respect to the integers is $x^2 + 1$.

Section 5.5 Factoring Trinomials

2. $z^2 + 6z + 9 = z^2 + 2(3z) + (3)^2$
$= (z + 3)(z + 3)$
$= (z + 3)^2$

4. $y^2 - 14y + 49 = y^2 - 2(7)y + (7)^2$
$= (y - 7)^2$

6. $4z^2 + 28z + 49 = (2z)^2 + 2(2z)(7) + (7)^2$
$= (2z + 7)(2z + 7)$
$= (2z + 7)^2$

8. $4x^2 - 4x + 1 = (2x)^2 - 2(2x)(1) + (1)^2$
$= (2x - 1)^2$

10. $x^2 - 14xy + 49y^2 = x^2 - 2(x)(7y) + (7y)^2$
$= (x - 7y)^2$

12. $4y^2 + 20yz + 25z^2 = (2y)^2 + 2(2y)(5z) + (5z)^2$
$= (2y + 5z)^2$

14. $4x^2 - 32x + 64 = 4(x^2 - 8x + 16)$
$= 4(x^2 - 2(x)(4) + 4^2)$
$= 4(x - 4)^2$

16. $3u^3 - 48u^2 + 192u = 3u(u^2 - 16u + 64)$
$= 3u(u^2 - 2(u)(8) + 8^2)$
$= 3u(u - 8)^2$

18. $-18y^3 - 12y^2 - 2y = -2y(9y^2 + 6y + 1)$
$= -2y((3y)^2 + 2(3y)(1) + 1^2)$
$= -2y(3y + 1)^2$

20. $\frac{1}{9}x^2 + \frac{8}{15}x + \frac{16}{25} = \left(\frac{1}{3}x\right)^2 + 2\left(\frac{1}{3}x\right)\left(\frac{4}{5}\right) + \left(\frac{4}{5}\right)^2 = \left(\frac{1}{3}x + \frac{4}{5}\right)^2$

or

$= \frac{25}{225}x^2 + \frac{120}{225}x + \frac{144}{225}$
$= \frac{1}{225}(25x^2 + 120x + 144)$
$= \frac{1}{225}((5x)^2 + 2(5x)(12) + 12^2) = \frac{1}{225}(5x + 12)^2$

22. $x^2 + bx + \frac{9}{16} = x^2 + bx + \left(\frac{3}{4}\right)^2$

(a) $b = \frac{3}{2}$

$x^2 + \frac{3}{2} \cdot x + \frac{9}{16} = x^2 + 2\left(\frac{3}{4}\right)x + \left(\frac{3}{4}\right)^2$
$= x^2 + \frac{3}{2}x + \frac{9}{16}$

or

(b) $b = -\frac{3}{2}$

$x^2 - \frac{3}{2}x + \frac{9}{16} = x^2 + 2\left(-\frac{3}{4}\right)x + \left(-\frac{3}{4}\right)^2$
$= x^2 - \frac{3}{2}x + \frac{9}{16}$

24. $16x^2 + bxy + 25y^2$

(a) $b = 40$

$16x^2 + 40xy + 25y^2 = (4x)^2 + 2(4x)(5y) + (5y)^2$
$= (4x + 5y)^2$

or

(b) $b = -40$

$16x^2 - 40xy + 25y^2 = (4x)^2 - 2(4x)(5y) + (5y)^2$
$= (4x - 5y)^2$

26. $x^2 + 12x + c$

$c = 36$

$x^2 + 12x + 36 = (x)^2 + 2(6)x + (6)^2$
$= (x + 6)^2$

28. $z^2 - 20z + c$

$c = 100$

$z^2 - 20z + 100 = (z)^2 - 2(10)z + (10)^2$
$= (z - 10)^2$

30. $a^2 + 2a - 8 = (a + 4)(a - 2)$

32. $y^2 + 6y + 8 = (y + 4)(y + 2)$

34. $x^2 + 7x + 12 = (x + 4)(x + 3)$

36. $z^2 + 2z - 24 = (z - 4)(z + 6)$

38. $x^2 + 7x + 10 = (x + 5)(x + 2)$

40. $x^2 - 10x + 24 = (x - 6)(x - 4)$

42. $m^2 - 3m - 10 = (m - 5)(m + 2)$

44. $x^2 + 4x - 12 = (x + 6)(x - 2)$

46. $y^2 - 35y + 300 = (y - 15)(y - 20)$

48. $u^2 + 5uv + 6v^2 = (u + 3v)(u + 2v)$

50. $a^2 - 21ab + 110b^2 = (a - 10b)(a - 11b)$

52. $b = 15$ $x^2 + 15x + 14 = (x + 14)(x + 1)$
$b = -15$ $x^2 - 15x + 14 = (x - 14)(x - 1)$
$x = 9$ $x^2 + 9x + 14 = (x + 7)(x + 2)$
$x = -9$ $x^2 - 9x + 14 = (x - 7)(x - 2)$

54. $b = 6$ $x^2 + 6x - 7 = (x + 7)(x - 1)$
$b = -6$ $x^2 - 6x - 7 = (x - 7)(x + 1)$

56. $b = 17$ $x^2 + 17x - 38 = (x + 19)(x - 2)$
$b = -17$ $x^2 - 17x - 38 = (x - 19)(x + 2)$
$b = 37$ $x^2 + 37x - 38 = (x + 38)(x - 1)$
$b = -37$ $x^2 - 37x - 38 = (x - 38)(x + 1)$

58. $c = 8$ $x^2 + 9x + 8 = (x + 8)(x + 1)$
$c = 14$ $x^2 + 9x + 14 = (x + 7)(x + 2)$
$c = -10$ $x^2 + 9x - 10 = (x + 10)(x - 1)$
$c = -36$ $x^2 + 9x - 36 = (x + 12)(x - 3)$
There are more possibilities.

60. There are many possibilities such as:
$c = 11$ $x^2 - 12x + 11 = (x - 11)(x - 1)$
$c = 20$ $x^2 - 12x + 20 = (x - 2)(x - 10)$
$c = 27$ $x^2 - 12x + 27 = (x - 9)(x - 3)$
Also note that if c is a negative number, there are many possibilities for c such as the following:
$c = -13$ $x^2 - 12x - 13 = (x - 13)(x + 1)$
$c = -28$ $x^2 - 12x - 28 = (x - 14)(x + 2)$
$c = -45$ $x^2 - 12x - 45 = (x - 15)(x + 3)$

62. $5x^2 + 19x + 12 = (x + 3)(5x + 4)$

64. $5c^2 + 11c - 12 = (c + 3)(5c - 4)$

66. $3y^2 - y - 30 = (y + 3)(3y - 10)$

68. $3x^2 - 16x - 12 = (3x + 2)(x - 6)$

70. $6x^2 - x - 15 = (3x - 5)(2x + 3)$

72. $3y^2 - 10y + 8 = (3y - 4)(y - 2)$

74. $15x^2 + 4x - 3 = (5x + 3)(3x - 1)$

76. $3z^2 - z - 4 = (3z - 4)(z + 1)$

78. $10x^2 - 24x - 18 = 2(5x^2 - 12x - 9)$
$= 2(5x + 3)(x - 3)$

80. $20x^2 + x - 12 = (5x + 4)(4x - 3)$

82. $-6x^2 + 5x - 6$ is Prime

84. $2 + 5x - 12x^2 = (2 - 3x)(1 + 4x)$

86. $12x^2 + 32x - 12 = 4(3x^2 + 8x - 3)$
$= 4(3x - 1)(x + 3)$

88. $12x^2 + 42x^3 - 54x^4 = 6x^2(2 + 7x - 9x^2)$
$= 6x^2(2 + 9x)(1 - x)$

90. $6u^2 - 5uv - 4v^2 = (3u - 4v)(2u + v)$

92. $10x^2 + 9xy - 9y^2 = (5x - 3y)(2x + 3y)$

94. $2x^2 + 9x + 9 = (2x^2 + 6x) + (3x + 9)$
$= 2x(x + 3) + 3(x + 3)$
$= (x + 3)(2x + 3)$

96. $6x^2 - x - 15 = (6x^2 - 10x) + (9x - 15)$
$= 2x(3x - 5) + 3(3x - 5)$
$= (3x - 5)(2x + 3)$

98. $12x^2 - 28x + 15 = (12x^2 - 18x) + (-10x + 15)$
$= 6x(2x - 3) - 5(2x - 3)$
$= (6x - 5)(2x - 3)$

100. $20y^2 - 45 = 5(4y^2 - 9)$
$= 5[(2y)^2 - (3)^2]$
$= 5(2y - 3)(2y + 3)$

102. $16z^3 - 56z^2 + 49z = z(16z^2 - 56z + 49)$
$= z[(4z)^2 - 2(4z)(7) + (7)^2]$
$= z(4z - 7)^2$

104. $3t^3 - 24 = 3(t^3 - 8)$
$= 3[t^3 - (2)^3]$
$= 3(t - 2)(t^2 + 2t + 4)$

106. $8m^3n + 20m^2n^2 - 48mn^3 = 4mn(2m^2 + 5mn - 12n^2)$
$= 4mn(2m - 3n)(m + 4n)$

108. $x^3 - 7x^2 - 4x + 28 = (x^3 - 7x^2) + (-4x + 28)$
$= x^2(x - 7) - 4(x - 7)$
$= (x - 7)(x^2 - 4)$
$= (x - 7)(x - 2)(x + 2)$

110. $(x + 7y)^2 - 4a^2 = [(x + 7y) - 2a][(x + 7y) + 2a]$
$= (x + 7y - 2a)(x + 7y + 2a)$

112. $a^2 - 2ab + b^2 - 16 = (a^2 - 2ab + b^2) - 16$
$= (a - b)^2 - 4^2$
$= (a - b - 4)(a - b + 4)$

114. $x^4 - 16y^4 = (x^2)^2 - (4y^2)^2$
$= (x^2 - 4y^2)(x^2 + 4y^2)$
$= (x - 2y)(x + 2y)(x^2 + 4y^2)$

116. $y^{2n} + y^n - 2 = (y^n + 2)(y^n - 1)$

118. $x^{2n} + 4x^n - 12 = (x^n + 6)(x^n - 2)$

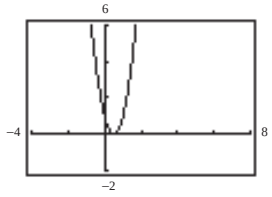
120. $3x^{2n} - 16x^n - 12 = (3x^n + 2)(x^n - 6)$

122. *Keystrokes:*

y_1 [Y=] 4 [X,T,θ] [x^2] [−] 4 [X,T,θ] [+] 1 [ENTER]

y_2 [(] 2 [X,T,θ] [−] 1 [)] [x^2] [GRAPH]

$y_1 = y_2$

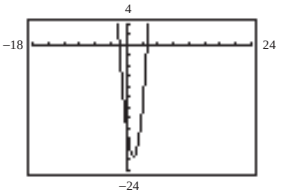


124. *Keystrokes:*

y_1 [Y=] 3 [X,T,θ] [x^2] [−] 8 [X,T,θ] [−] 16 [ENTER]

y_2 [(] 3 [X,T,θ] [+] 4 [)] [(] [X,T,θ] [−] 4 [)] [GRAPH]

$y_1 = y_2$



126. $a^2 + 2a + 1 = (a + 1)^2$ matches graph (a).

128. $ab + a + b - 1 = (a + 1)(b + 1)$ matches graph (d).

130. *Verbal Model:* Area of Shaded Region = Area of Larger Triangle − Area of Smaller Triangle

Equation:
$$\begin{aligned}\text{Area} &= \tfrac{1}{2} \cdot \tfrac{5}{4}(x + 3)(x + 3) - \tfrac{1}{2} \cdot 5 \cdot 4 \\ &= \tfrac{5}{8}(x + 3)^2 - \tfrac{5}{8} \cdot 16 \\ &= \tfrac{5}{8}(x^2 + 6x + 9 - 16) \\ &= \tfrac{5}{8}(x^2 + 6x - 7) \\ &= \tfrac{5}{8}(x + 7)(x - 1)\end{aligned}$$

132. (a)
$$\begin{aligned}8n^3 + 12n^2 - 2n - 3 &= (8n^3 + 12n^2) + (-2n - 3) \\ &= 4n^2(2n + 3) - 1(2n + 3) \\ &= (4n^2 - 1)(2n + 3) \\ &= (2n - 1)(2n + 1)(2n + 3)\end{aligned}$$

(b) If $n = 15$,

$2n - 1 = 2(15) - 1 = 29$

$2n + 1 = 2(15) + 1 = 31$

$2n + 3 = 2(15) + 3 = 33$

134. An example of a prime trinomial is $x^2 + x + 1$.

136. $3x + 6 = 3(x + 2)$ and $3x - 9 = 3(x - 3)$

so $(3x + 6)(3x - 9) = 3(x + 2) \cdot 3(x - 3)$

$= 9(x + 2)(x - 3)$ *not* $3(x + 2)(x - 3)$

138. $(2x - 4)(x + 1)$ is not in completely factored form because $2x - 4$ has the common factor 2, $2x - 4 = 2(x - 2)$

Section 5.6 Solving Polynomial Equations by Factoring

2. $z(z + 6) = 0$

$z = 0 \qquad z + 6 = 0$

$z = -6$

4. $(s - 16)(s + 15) = 0$

$s - 16 = 0 \qquad s + 15 = 0$

$s = 16 \qquad s = -15$

6. $17(t - 3)(t + 8) = 0$

$t - 3 = 0 \qquad t + 8 = 0$

$t = 3 \qquad t = -8$

8. $(5x - 3)(x - 8) = 0$

$5x - 3 = 0 \qquad x - 8 = 0$

$5x = 3 \qquad x = 8$

$x = \frac{3}{5}$

10. $\frac{1}{5}x(x - 2)(3x + 4) = 0$

$\frac{1}{5}x = 0 \qquad x - 2 = 0 \qquad 3x + 4 = 0$

$x = 0 \qquad x = 2 \qquad 3x = -4$

$x = -\frac{4}{3}$

12. $(y - 39)(2y + 7)(y + 12) = 0$

$y - 39 = 0 \qquad 2y + 7 = 0 \qquad y + 12 = 0$

$y = 39 \qquad 2y = -7 \qquad y = -12$

$y = -\frac{7}{2}$

14. $3x^2 + 9x = 0$

$3x(x + 3) = 0$

$x = 0 \qquad x + 3 = 0$

$x = -3$

16. $4x^2 - 6x = 0$

$2x(2x - 3) = 0$

$2x = 0 \qquad 2x - 3 = 0$

$x = 0 \qquad 2x = 3$

$x = \frac{3}{2}$

18. $8x^2 = 5x$

$8x^2 - 5x = 0$

$x(8x - 5) = 0$

$x = 0 \qquad 8x - 5 = 0$

$8x = 5$

$x = \frac{5}{8}$

20. $3x^2 = 7x$

$3x^2 - 7x = 0$

$x(3x - 7) = 0$

$x = 0 \qquad 3x - 7 = 0$

$3x = 7$

$x = \frac{7}{3}$

22. $x^2 - 121 = 0$

$(x - 11)(x + 11) = 0$

$x - 11 = 0 \quad x + 11 = 0$

$x = 11 \quad x = -11$

24. $25z^2 - 100 = 0$

$25(z^2 - 4) = 0$

$25(z - 2)(z + 2) = 0$

$z - 2 = 0 \quad z + 2 = 0$

$z = 2 \quad z = -2$

26. $x^2 - x - 12 = 0$

$(x - 4)(x + 3) = 0$

$x - 4 = 0 \quad x + 3 = 0$

$x = 4 \quad x = -3$

28. $20 - 9x + x^2 = 0$

$(5 - x)(4 - x) = 0$

$5 - x = 0 \quad 4 - x = 0$

$5 = x \quad 4 = x$

30. $14x^2 + 9x = -1$

$14x^2 + 9x + 1 = 0$

$(7x + 1)(2x + 1) = 0$

$7x + 1 = 0 \quad 2x + 1 = 0$

$x = -\frac{1}{7} \quad x = -\frac{1}{2}$

32. $11 + 32y - 3y^2 = 0$

$(11 - y)(1 + 3y) = 0$

$11 - y = 0 \quad 1 + 3y = 0$

$y = 11 \quad 3y = -1$

$y = -\frac{1}{3}$

34. $-2x - 15 = -x^2$

$x^2 - 2x - 15 = 0$

$(x - 5)(x + 3) = 0$

$x - 5 = 0 \quad x + 3 = 0$

$x = 5 \quad x = -3$

36. $x^2 - 15 = -2x$

$x^2 + 2x - 15 = 0$

$(x + 5)(x - 3) = 0$

$x + 5 = 0 \quad x - 3 = 0$

$x = -5 \quad x = 3$

38. $a^2 + 4a + 10 = 6$

$a^2 + 4a + 4 = 0$

$(a + 2)(a + 2) = 0$

$a + 2 = 0$

$a = -2$

40. $x^2 - 12x + 21 = -15$

$x^2 - 12x + 36 = 0$

$(x - 6)(x - 6) = 0$

$x - 6 = 0$

$x = 6$

42. $16t^2 + 48t + 40 = 4$

$16t^2 + 48t + 36 = 0$

$4(4t^2 + 12t + 9) = 0$

$4(2t + 3)(2t + 3) = 0$

$2t + 3 = 0$

$2t = -3$

$t = -\frac{3}{2}$

44. $x(x - 15) + 3(x - 15) = 0$

$(x - 15)(x + 3) = 0$

$x - 15 = 0 \quad x + 3 = 0$

$x = 15 \quad x = -3$

46. $x(x + 10) - 2(x + 10) = 0$

$(x + 10)(x - 2) = 0$

$x + 10 = 0 \quad x - 2 = 0$

$x = -10 \quad x = 2$

48. $s(s + 4) = 96$

$s^2 + 4s = 96$

$s^2 + 4s - 96 = 0$

$(s + 12)(s - 8) = 0$

$s + 12 = 0 \quad s - 8 = 0$

$s = -12 \quad s = 8$

50. $x(x - 4) = 12$

$x^2 - 4x = 12$

$x^2 - 4x - 12 = 0$

$(x - 6)(x + 2) = 0$

$x - 6 = 0 \quad x + 2 = 0$

$x = 6 \quad x = -2$

52. $3u(3u + 1) = 20$

$9u^2 + 3u = 20$

$9u^2 + 3u - 20 = 0$

$(3u - 4)(3u + 5) = 0$

$3u - 4 = 0 \quad 3u + 5 = 0$

$3u = 4 \quad 3u = -5$

$u = \frac{4}{3} \quad u = -\frac{5}{3}$

54. $(x-8)(x-7)=20$

$x^2-7x-8x+56=20$

$x^2-15x+36=0$

$(x-12)(x-3)=0$

$x-12=0 \qquad x-3=0$

$x=12 \qquad x=3$

56. $(u-6)(u+4)=-21$

$u^2-2u-24=-21$

$u^2-2u-3=0$

$(u-3)(u+1)=0$

$u-3=0 \qquad u+1=0$

$u=3 \qquad u=-1$

58. $(s+4)^2-49=0$

$[(s+4)-7][(s+4)+7]=0$

$(s-3)(s+11)=0$

$s-3=0 \qquad s+11=0$

$s=3 \qquad s=-11$

60. $1=(y+3)^2$

$1-(y+3)^2=0$

$[1-(y+3)][1+(y+3)]=0$

$(-y-2)(y+4)=0$

$-y-2=0 \qquad y+4=0$

$-y=2 \qquad y=-4$

$y=-2$

62. $1-(x+1)^2=0$

$[1-(x+1)][1+(x+1)]=0$

$(-x)(x+2)=0$

$-x=0 \qquad x+2=0$

$x=0 \qquad x=-2$

64. $(s+5)^2-49=0$

$[(s+5)-7][(s+5)+7]=0$

$(s-2)(s+12)=0$

$s-2=0 \qquad s+12=0$

$s=2 \qquad s=-12$

66. $x^3+18x^2+45x=0$

$x(x^2+18x+45)=0$

$x(x+15)(x+3)=0$

$x=0 \quad x+15=0 \quad x+3=0$

$x=-15 \quad x=-3$

68. $3u^3=5u^2+2u$

$3u^3-5u^2-2u=0$

$u(3u^2-5u-2)=0$

$u(3u+1)(u-2)=0$

$u=0 \quad 3u+1=0 \quad u-2=0$

$3u=-1 \quad u=2$

$u=-\frac{1}{3}$

70. $16(3-u)-u^2(3-u)=0$

$(3-u)(16-u^2)=0$

$(3-u)(4-u)(4+u)=0$

$3-u=0 \quad 4-u=0 \quad 4+u=0$

$3=u \qquad 4=u \qquad u=-4$

72. $x^3-2x^2-4x+8=0$

$x^2(x-2)-4(x-2)=0$

$(x-2)(x^2-4)=0$

$(x-2)(x-2)(x+2)=0$

$x-2=0 \quad x-2=0 \quad x+2=0$

$x=2 \qquad x=2 \qquad x=-2$

74. $v^3+4v^2-4v-16=0$

$v^2(v+4)-4(v+4)=0$

$(v+4)(v^2-4)=0$

$(v+4)(v-2)(v+2)=0$

$v+4=0 \quad v-2=0 \quad v+2=0$

$v=-4 \qquad v=2 \qquad v=-2$

76. $x^4+2x^3-9x^2-18x=0$

$x^3(x+2)-9x(x+2)=0$

$(x+2)(x^3-9x)=0$

$(x+2)x(x^2-9)=0$

$(x+2)x(x-3)(x+3)=0$

$x+2=0 \quad x=0 \quad x-3=0 \quad x+3=0$

$x=-2 \qquad x=3 \qquad x=-3$

78. $9x^4 - 15x^3 - 9x^2 + 15x = 0$

$3x^3(3x - 5) - 3x(3x - 5) = 0$

$(3x - 5)(3x^3 - 3x) = 0$

$(3x - 5)3x(x^2 - 1) = 0$

$(3x - 5)(3x)(x - 1)(x + 1) = 0$

$3x - 5 = 0 \quad 3x = 0 \quad x - 1 = 0 \quad x + 1 = 0$

$x = \frac{5}{3} \quad x = 0 \quad x = 1 \quad x = -1$

80. From the graph, the x-intercept is $(2, 0)$.
The solution of the equation $0 = x^2 - 4x + 4$ is 2.

$0 = x^2 - 4x + 4$

$0 = (x - 2)(x - 2)$

$x - 2 = 0 \quad x - 2 = 0$

$x = 2 \quad x = 2$

82. From the graph, the x-intercepts are $(-1, 0)$, $(1, 0)$, and $(3, 0)$. The solutions to the equation are -1, 1, and 3.

$0 = x^3 - 3x^2 - x + 3$

$0 = x^2(x - 3) - 1(x - 3)$

$0 = (x - 3)(x^2 - 1)$

$0 = (x - 3)(x - 1)(x + 1)$

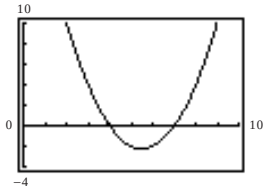
$x - 3 = 0 \quad x - 1 = 0 \quad x + 1 = 0$

$x = 3 \quad x = 1 \quad x = -1$

84. *Keystrokes:*

Y= (X,T,θ) x² − 11 X,T,θ + 28 GRAPH

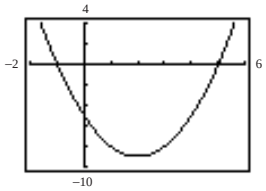
The x-intercepts are 4 and 7, so the solutions are 4 and 7.



86. *Keystrokes:*

Y= (X,T,θ − 2) x² − 9 GRAPH

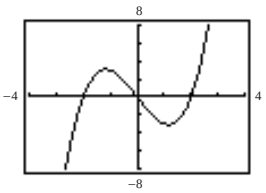
The x-intercepts are -1 and 5, so the solutions are -1 and 5.



88. *Keystrokes:*

Y= X,T,θ ^ 3 − 4 X,T,θ GRAPH

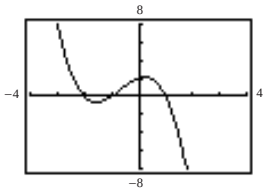
The x-intercepts are -2, 0, and 2, so the solutions are -2, 0, and 2.



90. *Keystrokes:*

Y= 2 + X,T,θ − 2 X,T,θ x² − X,T,θ ^ 3 GRAPH

The x-intercepts are -2, -1, and 1, so the solutions are -2, -1, and 1.



92. $ax^2 - ax = 0$

$ax(x - 1) = 0$

$ax = 0 \quad x - 1 = 0$

$x = \frac{0}{a} \quad x = 1$

$x = 0 \quad x = 1$

94. $x = 1$ and $x = 6$

$(x - 1)(x - 6) = 0$

$x^2 - 7x + 6 = 0$

96. *Verbal Model:* [First Integer] · [Second Integer] = [132]

Labels: First integer = x

Second integer $x + 1$

Equation: $x \cdot (x + 1) = 132$

$x^2 + x - 132 = 0$

$(x + 12)(x - 11) = 0$

$x + 12 = 0$ $\qquad$ $x - 11 = 0$

$x = -12$ $\qquad$ $x = 11$ 1st integer

reject $\qquad$ $x + 1 = 12$ 2nd integer

98. *Verbal Model:* [Area of exposed picture] = [Length] · [Width]

Labels: Length = $(28 - 2w)$

Width = $(20 - 2w)$

Equation: $468 = (28 - 2w)(20 - 2w)$

$468 = 560 - 56w - 40w + 4w^2$

$0 = 92 - 96w + 4w^2$

$0 = 4(23 - 24w + w^2)$

$0 = 2(1 - w)(23 - w)$

$1 - w = 0$ $\qquad$ $23 - w = 0$

$23 = w$

$1 = w$ $\qquad$ reject

The width of the frame is 1 cm.

100. *Verbal Model:* [Area] = $\frac{1}{2}$ [Base] · [Height]

Labels: Base = x

Height = $x - 4$

Equation: $70 = \frac{1}{2}x(x - 4)$

$70 = \frac{1}{2}x^2 - 2x$

$0 = \frac{1}{2}x^2 - 2x - 70$

$0 = x^2 - 4x - 140$

$0 = (x - 14)(x + 10)$

$x - 14 = 0$ $\qquad$ $x + 10 = 0$

$x = 14$ $\qquad$ $x = -10$

reject

The base of the triangle is 14 inches.

The height is $14 - 4 = 10$ inches.

102. $S = x^2 + 4xh$

$880 = x^2 + 4x(6)$

$0 = x^2 + 24x - 880$

$0 = (x - 20)(x + 44)$

$0 = x - 20$ $\qquad$ $0 = x + 44$

$20 = x$ $\qquad$ $-44 = x$

$20" \times 20"$ $\qquad$ reject

104. $-16t^2 + 576 = 0$

$-16(t^2 - 36) = 0$

$-16(t - 6)(t + 6) = 0$

$t - 6 = 0$ $\qquad$ $t + 6 = 0$

$t = 6$ $\qquad$ $t = -6$

Thus, the object reaches the ground after 6 seconds.

106. $h = -16t^2 + 16t + 32$

$0 = -16t^2 + 16t + 32$

$0 = -16(t^2 - t - 2)$

$0 = -16(t - 2)(t + 1)$

$t - 2 = 0 \qquad t + 1 = 0$

$t = 2 \qquad t = -1$

reject

The object reaches the ground after 2 seconds.

108. $h = -16t^2 + 80t$

$96 = -16t^2 + 80t$

$0 = -16t^2 + 80t - 96$

$0 = -16(t^2 - 5t + 6)$

$0 = -16(t - 2)(t - 3)$

$t - 2 = 0 \qquad t - 3 = 0$

$t = 2$ seconds $\qquad t = 3$ seconds

The object reaches your friend on the way up at 2 seconds and at 3 seconds on the way down.

110. *Verbal Model:* $\boxed{\text{Revenue}} = \boxed{\text{Cost}}$

Equation: $60x - x^2 = 75 + 40x$

$0 = x^2 - 20x + 75$

$0 = (x - 5)(x - 15)$

$x - 5 = 0 \qquad x - 15 = 0$

$x = 5$ units $\qquad x = 15$ units

112. (a) $3(x + 6)^2 - 10(x + 6) - 8 = 0$

let $u = (x + 6)$

$3u^2 - 10u - 8 = 0$

$(3u + 2)(u - 4) = 0$

$3u + 2 = 0 \qquad u - 4 = 0$

$u = -\frac{2}{3} \qquad u = 4$

$x + 6 = -\frac{2}{3} \qquad x + 6 = 4$

$x = -\frac{20}{3} \qquad x = -2$

or

$3(x^2 + 12x + 36) - 10x - 60 - 8 = 0$

$3x^2 + 36x + 108 - 10x - 68 = 0$

$3x^2 + 26x + 40 = 0$

$(3x + 20)(x + 2) = 0$

$3x + 20 = 0 \qquad x + 2 = 0$

$3x = -20 \qquad x = -2$

$x = -\frac{20}{3}$

(b) $8(x + 2)^2 - 18(x + 2) + 9 = 0$

let $u = (x + 2)$

$8u^2 - 18u + 9 = 0$

$(4u - 3)(2u - 3) = 0$

$4u - 3 = 0 \qquad 2u - 3 = 0$

$u = \frac{3}{4} \qquad u = \frac{3}{2}$

$x + 2 = \frac{3}{4} \qquad x + 2 = \frac{3}{2}$

$x = -\frac{5}{4} \qquad x = -\frac{1}{2}$

or

$8(x^2 + 4x + 4) - 18x - 36 + 9 = 0$

$8x^2 + 32x + 32 - 18x - 36 + 9 = 0$

$8x^2 + 14x + 5 = 0$

$(4x + 5)(2x + 1) = 0$

$4x + 5 = 0 \qquad 2x + 1 = 0$

$4x = -5 \qquad 2x = -1$

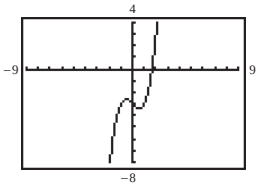
$x = -\frac{5}{4} \qquad x = -\frac{1}{2}$

114. An example of how the Zero-Factor Property can be used to solve a quadratic equation: If $x(x - 2) = 0$, then $x = 0$ or $x - 2 = 0$. The solutions are $x = 0$ and $x = 2$.

116. Yes, it is possible for a quadratic equation to have only one solution. For example:

$$x^2 + 2x + 1 = 0$$
$$(x + 1)^2 = 0$$
$$x = -1$$

118. (a)



From the graph, the solution is between $x = 1$ and $x = 2$.

(b)

x	-1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
$x^3 - x - 3$	-3.0	-2.769	-2.472	-2.103	-1.656	-1.125	-0.504	0.213	1.032	1.959	3.0

From this table, the solution is between $x = 1.6$ and $x = 1.7$.

x	1.60	1.61	1.62	1.63	1.64	1.65	1.66	1.67	1.68	1.69	1.70
$x^3 - x - 3$	-0.504	-0.437	-0.368	-0.299	-0.229	-0.158	-0.086	-0.0125	-0.062	0.137	0.213

An estimate of the solution from the table is $x \approx 1.67$.

Review Exercises for Chapter 5

2. $-3y^2 \cdot y^4 = -3y^{2+4} = -3y^6$

4. $(v^4)^2 = v^{4 \cdot 2} = v^8$

6. $(-3y)^2(2) = (-3)^2y^2(2)$
$= 9y^2(2)$
$= 18y^2$

8. $(12x^2y)(3x^2y^4)^2 = (12x^2y)(9x^4y^8)$
$= (12 \cdot 9)x^{2+4}y^{1+8}$
$= 108x^6y^9$

10. $\dfrac{15m^3}{25m} = \left(\dfrac{15}{25}\right)m^{3-1} = \dfrac{3}{5}m^2$

12. $-\dfrac{(-2x^2y^3)^2}{-3xy^2} = -\dfrac{4(x^2)^2(y^3)^2}{-3xy^2}$
$= -\dfrac{4x^4y^6}{-3xy^2}$
$= \dfrac{4x^{4-1}y^{6-2}}{3}$
$= \dfrac{4x^3y^4}{3}$

14. $\left(-\dfrac{1}{2}y^2\right)^3 = \left(-\dfrac{1}{2}\right)^3(y^2)^3$
$= -\dfrac{1}{8}y^6$

16. $(2^{-2} \cdot 5^2)^{-2} = \left(\dfrac{1}{2^2} \cdot 5^2\right)^{-2}$
$= \left(\dfrac{25}{4}\right)^{-2}$
$= \left(\dfrac{4}{25}\right)^2$
$= \dfrac{16}{625}$

18. $\left(\dfrac{1}{3^{-2}}\right)^2 = (3^2)^2 = 3^4 = 81$

20. $4(-3x)^{-3} = \dfrac{4}{(-3x)^3} = -\dfrac{4}{27x^3}$

22. $\dfrac{15t^5}{24t^{-3}} = \dfrac{5}{8}t^{5-(-3)} = \dfrac{5}{8}t^8$

24. $(5x^{-2}y^4)^{-2} = \left(\dfrac{1}{5x^{-2}y^4}\right)^2 = \dfrac{1}{5^2x^{-4}y^8} = \dfrac{x^4}{25y^8}$

26. $\dfrac{2u^0v^{-2}}{10u^{-1}v^{-3}} = \dfrac{1u^{0-(-1)}v^{(-2)-(-3)}}{5} = \dfrac{uv}{5}$

28. $\left(\dfrac{4x^{-3}z^{-1}}{8x^4z}\right)^{-2} = \left(\dfrac{8x^4z}{4x^{-3}z^{-1}}\right)^2 = [2x^{4-(-3)}z^{1-(-1)}]^2 = (2x^7z^2)^2 = 4x^{14}z^4$

30. $a^4(2a^{-1}b^2)(ab)^0 = (2)a^{4+(-1)}b^2(1) = 2a^3b^2$

32. $30{,}296{,}000{,}000 = 3.0296 \times 10^{10}$

34. $2.74 \times 10^{-4} = 0.000274$

36. $(3 \times 10^{-3})(8 \times 10^7) = 24 \times 10^{-3+7} = 24 \times 10^4 = 2.4 \times 10^5$

38. $\dfrac{1}{(6 \times 10^{-3})^2} = \dfrac{1}{36 \times 10^{-6}} = \dfrac{10^6}{36} = \dfrac{1{,}000{,}000}{36} = \dfrac{250{,}000}{9}$

40. Standard form: $2x^6 + x^5 - 5x^3 - 7$

Leading coefficient: 2

Degree: 6

42. Standard form: $-8x^7 + x^5 - 2x^3 + 9x$

Leading coefficient: -8

Degree: 7

44. Binomial of degree 2 and leading coefficient 7:

$7x^2 - 6x$

46. $(-7x + 3) + (x^2 - 18) = x^2 + (-7x) + (3 - 18) = x^2 - 7x - 15$

48. $(7 - 12x^2 + 8x^3) + (x^4 - 6x^3 + 7x^2 - 5) = x^4 + (8x^3 - 6x^3) + (-12x^2 + 7x^2) + (7 - 5) = x^4 + 2x^3 - 5x^2 + 2$

50. $(x^2 - 5) - (3 - 6x) = (x^2 - 5) + (-3 + 6x) = x^2 + 6x + (-5 + -3) = x^2 + 6x - 8$

52. $(7z^2 + 6z) - 3(5z^2 + 2z) = 7z^2 + 6z - 15z^2 - 6z = (7z^2 - 15z^2) + (6z - 6z) = -8z^2$

54. $(16a^3 + 5a) - 5[a + (2a^3 - 1)] = 16a^3 + 5a - 5a - 10a^3 + 5 = (16a^3 - 10a^3) + (5a - 5a) + 5 = 6a^3 + 5$

56. $(7x^4 - 10x^2 + 4x) + (x^3 - 3x) - (3x^4 - 5x^2 + 1) =$

$(7x^4 - 3x^4) + x^3 + (-10x^2 + 5x^2) + (4x - 3x) - 1 = 4x^4 + x^3 - 5x^2 + x - 1$

58.
$$\begin{array}{r} 6x + 1 \\ \underline{x^2 - 4x} \\ x^2 + 2x + 1 \end{array}$$

60.
$$\begin{array}{r} 10y^2 \quad + 3 \\ \underline{-y^2 + 4y - 9} \end{array} \Rightarrow \begin{array}{r} 10y^2 \quad + \ 3 \\ \underline{-y^2 - 4y + \ 9} \\ 9y^2 - 4y + 12 \end{array}$$

62. Perimeter $= 7 + 8x + (x + 12) + (6x - 2) + x + 2x + 2x + x$

$= 21x + 17$

64. *Verbal Model:* $\boxed{\text{Profit}} = \boxed{\text{Revenue}} - \boxed{\text{Cost}}$

Equation: $P(x) = 1.1x - (0.5x + 1000)$

$= 1.1x - 0.5x - 1000$

$= 0.6x - 1000$

$P(5000) = 0.6(5000) - 1000$

$= 3000 - 1000$

$= \$2000$

66. $(-4y)^2(y - 2) = 16y^2(y - 2)$

$= 16y^3 - 32y^2$

68. $-2y(5y^2 - y - 4) = -10y^3 + 2y^2 + 8y$

70. $(x + 6)(x - 9) = x^2 - 9x + 6x - 54$

$= x^2 - 3x - 54$

72. $(4x - 1)(2x - 5) = 8x^2 - 20x - 2x + 5$

$= 8x^2 - 22x + 5$

74. $(3y^2 + 2)(4y^2 - 5) = 3y^2(4y^2 - 5) + 2(4y^2 - 5)$

$= 12y^4 - 15y^2 + 8y^2 - 10$

$= 12y^4 - 7y^2 - 10$

76. $(5s^3 + 4s - 3)(4s - 5) = 5s^3(4s - 5) + 4s(4s - 5) - 3(4s - 5)$

$= 20s^4 - 25s^3 + 16s^2 - 20s - 12s + 15$

$= 20s^4 - 25s^3 + 16s^2 - 32s + 15$

78. $(3v + 2)(-5v) + 5v(3v + 2) = -15v^2 - 10v + 15v^2 + 10v$

$= 0$

80. $(2x + 3y)^2 = (2x)^2 + 2(2x)(3y) + (3y)^2$

$= 4x^2 + 12xy + 9y^2$

82. $(5x - 2y)(5x + 2y) = (5x)^2 - (2y)^2 = 25x^2 - 4y^2$

84. $[(m - 5) + n]^2 = (m - 5)^2 + 2(m - 5)n + n^2$

$= m^2 - 2m(5) + 5^2 + 2nm - 10n + n^2$

$= m^2 - 10m + 25 + 2mn - 10n + n^2$

86. *Verbal Model:* $\boxed{\text{Area of Shaded Region}} = \boxed{\text{Area of Larger Triangle}} - \boxed{\text{Area of Smaller Triangle}}$

Equation: $\text{Area} = \frac{1}{2} \cdot (3x + 10)(3x) - \frac{1}{2}(3x)(2x)$

$= \frac{3}{2}x(3x + 10) - (3x)(x)$

$= \frac{9}{2}x^2 + 15x - 3x^2$

$= \frac{9}{2}x^2 - \frac{6}{2}x^2 + 15x$

$= \frac{3}{2}x^2 + 15x$ or $\frac{3}{2}x(x + 10)$

88. $750(1 + r)^2 = 750(1 + 2r + r^2)$

$= 750 + 1500r + 750r^2$

or

$750r^2 + 1500r + 750$

90. $14z^3 + 21 = 7(z^3 + 3)$

92. $-a^3 - 4a = -a(a^2 + 4)$

94. $8y - 12y^2 + 24y^3 = 4y(2 - 3y + 6y^2)$

96. $(u - 9v)(u - v) + v(u - 9v) = (u - 9v)(u - v + v)$
$= u(u - 9v)$

98. $y^3 + 4y^2 - y - 4 = (y^3 + 4y^2) + (-y - 4)$
$= y^2(y + 4) - (y + 4)$
$= (y + 4)(y^2 - 1)$
$= (y + 4)(y - 1)(y + 1)$

100. $x^3 + 7x^2 + 3x + 21 = (x^3 + 7x^2) + (3x + 21)$
$= x^2(x + 7) + 3(x + 7)$
$= (x + 7)(x^2 + 3)$

102. $16y^2 - 49 = (4y)^2 - (7)^2$
$= (4y - 7)(4y + 7)$

104. $(y - 3)^2 - 16 = (y - 3)^2 - (4)^2$
$= (y - 3 - 4)(y - 3 + 4)$
$= (y - 7)(y + 1)$

106. $t^3 - 125 = t^3 - 5^3$
$= (t - 5)(t^2 + 5t + 25)$

108. $64y^3 + 8 = (4y)^3 + (2)^3$
$= (4y + 2)(16y^2 - 8y + 4)$

110. $y^4 - 4y^2 = y^2(y^2 - 4)$
$= y^2(y - 2)(y + 2)$

112. $54 - 2x^3 = -2(-27 + x^3)$
$= -2(x^3 - 27)$
$= -2(x^3 - 3^3)$
$= -2(x - 3)(x^2 + 3x + 9)$

114. $y^2 + 16y + 64 = y^2 + 2(8)y + (8)^2$
$= (y + 8)^2$

116. $u^2 - 10uv + 25v^2 = u^2 - 2(u)(5v) + (5v)^2$
$= (u - 5v)^2$

118. $x^2 - 12x + 32 = (x - 8)(x - 4)$

120. $5x^2 + 11x - 12 = (5x - 4)(x + 3)$

122. $12x^2 - 13x - 14 = (4x - 7)(3x + 2)$

124. $12x^2 - 7x + 1 = 12x^2 - 4x - 3x + 1$
$= 4x(3x - 1) - 1(3x - 1)$
$= (4x - 1)(3x - 1)$

126. $3u^2 + 7u - 6 = 3u^2 + 9u - 2u - 6$
$= 3u(u + 3) - 2(u + 3)$
$= (3u - 2)(u + 3)$

128. $3x^2 - 13x - 10 = 3x^2 - 15x + 2x - 10$
$= 3x(x - 5) + 2(x - 5)$
$= (3x + 2)(x - 5)$

130. $3b + 27b^3 = 3b(1 + 9b^2)$

132. $x^3 + 3x^2 - 4x - 12 = x^2(x + 3) - 4(x + 3)$
$= (x + 3)(x^2 - 4)$
$= (x + 3)(x - 2)(x + 2)$

134. $x^2 - \frac{2}{3}x + \frac{1}{9} = x^2 - 2\left(\frac{1}{3}\right)x + \left(\frac{1}{3}\right)^2$
$= \left(x - \frac{1}{3}\right)^2$

136. $u^6 - 8v^6 = (u^2)^3 - (2v^2)^3$
$= (u^2 - 2v^2)(u^4 + 2u^2v^2 + 4v^4)$

138. $-7x(2x + 5) = 0$

$-7x = 0 \qquad 2x + 5 = 0$

$x = 0 \qquad x = -\frac{5}{2}$

140. $(x - 7)(3x - 8) = 0$

$x - 7 = 0 \qquad 3x - 8 = 0$

$x = 7 \qquad x = \frac{8}{3}$

142. $3x(x + 8)(2x - 7) = 0$

$3x = 0 \qquad x + 8 = 0 \qquad 2x - 7 = 0$

$x = 0 \qquad x = -8 \qquad x = \frac{7}{2}$

144. $x^2 - 25x = -150$

$x^2 - 25x + 150 = 0$

$(x - 15)(x - 10) = 0$

$x - 15 = 0 \quad x - 10 = 0$

$x = 15 \qquad x = 10$

146. $3x(4x + 7) = 0$

$3x = 0 \quad 4x + 7 = 0$

$x = 0 \qquad 4x = -7$

$x = -\frac{7}{4}$

148. $(x + 3)^2 - 25 = 0$

$(x + 3 - 5)(x + 3 + 5) = 0$

$(x - 2)(x + 8) = 0$

$x - 2 = 0 \quad x + 8 = 0$

$x = 2 \qquad x = -8$

150. $x^2 - 121 = 0$

$(x - 11)(x + 11) = 0$

$x - 11 = 0 \quad x + 11 = 0$

$x = 11 \qquad x = -11$

152. $9x^4 - 15x^3 - 6x^2 = 0$

$3x^2(3x^2 - 5x - 2) = 0$

$3x^2(3x + 1)(x - 2) = 0$

$3x^2 = 0 \qquad 3x + 1 = 0 \qquad x - 2 = 0$

$x = 0 \qquad x = -\frac{1}{3} \qquad x = 2$

154. $x^3 + 20x^2 + 36x = 0$

$x(x^2 + 20x + 36) = 0$

$x(x + 18)(x + 2) = 0$

$x = 0 \qquad x + 18 = 0 \qquad x + 2 = 0$

$x = -18 \qquad x = -2$

156. $x^3 + 3x^2 - 5x - 15 = 0$

$x^2(x + 3) - 5(x + 3) = 0$

$(x^2 - 5)(x + 3) = 0$

$\left(x - \sqrt{5}\right)\left(x + \sqrt{5}\right)(x + 3) = 0$

$x - \sqrt{5} = 0 \qquad x + \sqrt{5} = 0 \qquad x + 3 = 0$

$x = \sqrt{5} \qquad x = -\sqrt{5} \qquad x = -3$

158. $2x^4 + 6x^3 - 50x^2 - 150x = 0$

$2x^3(x + 3) - 50x(x + 3) = 0$

$(2x^3 - 50x)(x + 3) = 0$

$2x(x^2 - 25)(x + 3) = 0$

$2x(x - 5)(x + 5)(x + 3) = 0$

$2x = 0 \qquad x - 5 = 0 \qquad x + 5 = 0 \qquad x + 3 = 0$

$x = 0 \qquad x = 5 \qquad x = -5 \qquad x = -3$

160. *Verbal Model:* [First even integer] · [Second even integer] = [224]

Labels: First even integer $= 2n$

Second even integer $= 2n + 2$

Equation: $2n \cdot (2n + 2) = 224$

$4n^2 + 4n - 224 = 0$

$4(n^2 + n - 56) = 0$

$4(n + 8)(n - 7) = 0$

$n + 8 = 0 \qquad n - 7 = 0$

$n = -8 \qquad n = 7$

reject $2n = 14$

$2n + 2 = 16$

162. *Verbal Model:* Area = [Length] · [Width]

Labels: Length $= x$

Width $= \frac{3}{4}x$

Equation: $432 = x \cdot \frac{3}{4}x$

$432 = \frac{3}{4}x^2$

$1728 = 3x^2$

$576 = x^2$

$24 = x$

$18 = \frac{3}{4}x$

24 inches $\times$ 18 inches

164. $0 = -16t^2 + 45t + 664$

$0 = 16t^2 - 45t - 664$

$0 = (16t + 83)(t - 8)$

$0 = 16t + 83 \qquad 0 = t - 8$

$-\frac{83}{16} = t \qquad 8 = t$

reject

8 seconds