C H A P T E R P
Prerequisites

Section P.1 Real Numbers **2**

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C H A P T E R P
Prerequisites

Section P.1 Real Numbers

1. rational

2. Irrational

3. prime

4. variables, constants

5. terms

6. Yes. $|5-2| = |2-5| \Rightarrow |3| = |-3| = 3$

7. (c) Commutative Property of Addition: $a + b = b + a$

8. (d) Associative Property of Multiplication: $(ab)c = a(bc)$

9. (e) Additive Inverse Property: $a + (-a) = 0$

10. (b) Distributive Property: $a(b + c) = ab + ac$

11. (f) Associative Property of Addition: $(a + b) + c = a + (b + c)$

12. (a) Multiplicative Identity Property: $a \cdot 1 = a$

13. $\left\{-9,\ -\frac{7}{2},\ 5,\ \frac{2}{3},\ \sqrt{2},\ 0,\ 1,\ -4,\ -1\right\}$

(a) Natural numbers: 5, 1
(b) Whole numbers: 5, 0, 1
(c) Integers: –9, 5, 0, 1, -4, -1
(d) Rational numbers: –9, $-\frac{7}{2}$, 5, $\frac{2}{3}$, 0, 1, -4, -1
(e) Irrational number: $\sqrt{2}$

14. $\left\{\sqrt{5},\ -7,\ -\frac{7}{3},\ 0,\ 3.12,\ \frac{5}{4},\ -2,\ -8,\ 3\right\}$

(a) Natural number: 3
(b) Whole numbers: 0, 3
(c) Integers: -7, 0, -2, -8, 3
(d) Rational numbers: $-7,\ -\frac{7}{3},\ 0,\ 3.12,\ \frac{5}{4},\ -2,\ -8,\ 3$
(e) Irrational number: $\sqrt{5}$

15. {2.01, 0.666…, -13, 0.010110111…, 1, -10, 20}

(a) Natural numbers: 1, 20
(b) Whole numbers: 1, 20
(c) Integers: -13, 1, -10, 20
(d) Rational numbers: 2.01, 0.666…, -13, 1, -10, 20
(e) Irrational number: 0.010110111…

16. {2.3030030003…, 0.7575, -4.63, $\sqrt{10}$, -2, 0.3, 8}

(a) Natural number: 8
(b) Whole number: 8
(c) Integers: –2, 8
(d) Rational numbers: 0.7575, -4.63, -2, 0.3, 8
(e) Irrational numbers: 2.3030030003…, $\sqrt{10}$

17. $\left\{-\pi,\ -\frac{1}{3},\ \frac{6}{3},\ \frac{1}{2}\sqrt{2},\ -7.5,\ -2,\ 3,\ -3\right\}$

(a) Natural numbers: $\frac{6}{3}$ (since it equals 2), 3
(b) Whole numbers: $\frac{6}{3}$, 3
(c) Integers: $\frac{6}{3}$, -2, 3, -3
(d) Rational numbers: $-\frac{1}{3}$, $\frac{6}{3}$, -7.5, -2, 3, -3
(e) Irrational numbers: $-\pi$, $\frac{1}{2}\sqrt{2}$

18. $\left\{25,\ -17,\ -\frac{12}{5},\ \sqrt{9},\ 3.12,\ \frac{1}{2}\pi,\ 6,\ -4,\ 18\right\}$

(a) Natural numbers: 25, $\sqrt{9} = 3$, 6, 18
(b) Whole numbers: 25, $\sqrt{9} = 3$, 6, 18
(c) Integers: 25, -17, $\sqrt{9}$, 6, -4, 18
(d) Rational numbers: 25, -17, $-\frac{12}{5}$, $\sqrt{9}$, 3.12, 6, -4, 18
(e) Irrational number: $\frac{1}{2}\pi$

19. $\frac{5}{16} = 0.3125$

20. $\frac{17}{4} = 4.25$

21. $\frac{41}{333} = 0.\overline{123}$

22. $\frac{3}{7} = 0.\overline{428571}$

23. $-\frac{100}{11} = -9.\overline{09}$

24. $-\frac{218}{33} = -6.\overline{60}$

25. $6.4 = 6\frac{4}{10} = \frac{64}{10} = \frac{32}{5}$

26. $-7.5 = -7\frac{5}{10} = -\frac{75}{10} = -\frac{15}{2}$

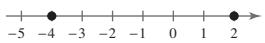
27. $-12.3 = -12\frac{3}{10} = -\frac{123}{10}$

28. $1.87 = 1\frac{87}{100} = \frac{187}{100}$

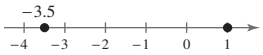
29. $-1 < 2.5$

30. $-6 < -2.5$

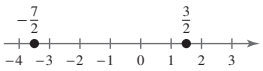
31. $-4 < 2$



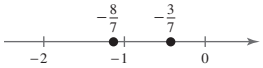
32. $-3.5 < 1$



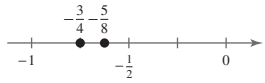
33. $\frac{3}{2} > -\frac{7}{2}$



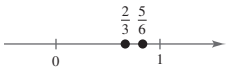
34. $-\frac{8}{7} < -\frac{3}{7}$



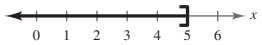
35. $-\frac{3}{4} < -\frac{5}{8}$



36. $\frac{5}{6} > \frac{2}{3}$



37. (a) The inequality $x \le 5$ is the set of all real numbers less than or equal to 5.

(b) 

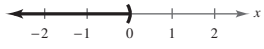
(c) The interval is unbounded.

38. (a) The inequality $x > -3$ is the set of all real numbers greater than -3.

(b) 

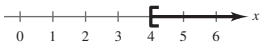
(c) The interval is unbounded.

39. (a) The inequality $x < 0$ is the set of all negative real numbers.

(b) 

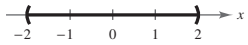
(c) The interval is unbounded.

40. (a) The inequality $x \ge 4$ is the set of all real numbers greater than or equal to 4.

(b) 

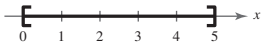
(c) The interval is unbounded.

41. (a) The inequality $-2 < x < 2$ is the set of all real numbers greater than -2 and less than 2.

(b) 

(c) The interval is bounded.

42. (a) The inequality $0 \le x \le 5$ is the set of all real numbers greater than or equal to zero and less than or equal to 5.

(b) 

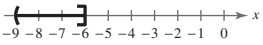
(c) The interval is bounded.

43. (a) The inequality $-1 \le x < 0$ is the set of all negative real numbers greater than or equal to -1.

(b) 

(c) The interval is bounded.

44. (a) The inequality $-9 < x \le -6$ is the set of all real numbers greater than -9 and then less than or equal to -6.

(b) 

(c) The interval is bounded.

45. $x < 0;\ (-\infty, 0)$

46. $y \ge 0;\ [0, \infty)$

47. $z \ge 10,\ [10, \infty)$

48. $y \le 25,\ (-\infty, 25]$

49. $9 \le t \le 24;\ [9, 24]$

50. $-1 \le k < 3;\ [-1, 3)$

51. $0 < m \le 5$ or $(0, 5]$

52. $2.5\% \le r \le 5\%;\ [0.025, 0.05]$

53. $-3 \le x < 8$ or $[-3, 8)$

54. $-4 < x \le 4$ or $(-4, 4]$

55. $[-a, a+4]$

56. $(-c+2, c+1)$

57. The interval $(-6, \infty)$ consists of all real numbers greater than -6.

58. The interval $(-\infty, 4]$ consists of all real numbers less than or equal to 4.

59. The interval $(-\infty, 2]$ consists of all real numbers less than or equal to 2.

60. The interval $(1, \infty)$ consists of all real numbers greater than 1.

61. $|-10| = -(-10) = 10$

62. $|0| = 0$

63. $-3 - |-3| = -3 - 3 = -6$

64. $|-1| - |-2| = (1) - (2) = -1$

65. $\dfrac{-5}{|-5|} = \dfrac{-5}{5} = -1$

66. $-3|-3| = -3(3) = -9$

67. (a) If $x > -1 \Rightarrow x + 1 > 0$, then $\dfrac{|x+1|}{x+1} = \dfrac{x+1}{x+1} = 1$.

(b) If $x < -1 \Rightarrow x + 1 < 0$, then $\dfrac{|x+1|}{x+1} = \dfrac{-(x+1)}{x+1} = -1$.

68. (a) If $x > 2 \Rightarrow x - 2 > 0$, then $\dfrac{|x-2|}{x-2} = \dfrac{x-2}{x-2} = 1$.

(b) If $x < 2 \Rightarrow x - 2 > 0$, then $\dfrac{|x-2|}{x-2} = \dfrac{-(x-2)}{x-2} = -1$.

69. $|y - 4x| = |-3 - 4(2)|$
$= |-3 - 8| = |-11| = 11$

70. $|x| - 2|y| = |-2| - 2|-1| = 2 - 2(1) = 0$

71. $\left|\dfrac{3x+2y}{|x|}\right| = \left|\dfrac{3(4)+2(1)}{|4|}\right|$
$= \left|\dfrac{12+2}{4}\right| = \dfrac{14}{4} = \dfrac{7}{2}$

72. $\left|\dfrac{3|x|-2y}{2x+y}\right| = \left|\dfrac{3|-2|-2(-4)}{2(-2)+(-4)}\right|$
$= \left|\dfrac{3(2)+8}{(-4)+(-4)}\right| = \left|\dfrac{14}{-8}\right| = \dfrac{7}{4}$

73. $|-3| > -|-3|$ since $3 > -3$.

74. $|-4| = |4|$ since $|-4| = 4$ and $|4| = 4$.

75. $-5 = -|5|$ since $-5 = -5$.

76. $-|-6| < |-6|$ since $|-6| = 6$ and $-|-6| = -(6) = -6$.

77. $-|-1| < -(-1)$ since $-1 < 1$.

78. $-(-2) > -|2|$ since $-(-2) = 2$.

79. $d(126, 75) = |75 - 126| = 51$

80. $d(-126, -75) = |-126 - (-75)|$
$= |-126 + 75|$
$= |-51| = 51$

81. $d\left(-\frac{5}{2}, \frac{9}{2}\right) = \left|\frac{9}{2} - \left(-\frac{5}{2}\right)\right| = \left|\frac{14}{2}\right| = |7| = 7$

82. $d\left(\frac{1}{4}, \frac{11}{4}\right) = \left|\frac{1}{4} - \frac{11}{4}\right|$
$= \left|-\frac{10}{4}\right| = \frac{10}{4} = \frac{5}{2}$

83. $d\left(\frac{16}{5}, \frac{112}{75}\right) = \left|\frac{112}{75} - \frac{16}{5}\right| = \frac{128}{75}$

84. $d\left(-\frac{15}{8}, \frac{7}{3}\right) = \left|\frac{7}{3} - \left(-\frac{15}{8}\right)\right| = \left|\frac{56+45}{24}\right| = \left|\frac{101}{24}\right| = \frac{101}{24}$

85. $d(x, 5) = |x - 5|$ and $d(x, 5) \le 3$
Thus, $|x - 5| \le 3$.

86. $d(x, -10) = |x - (-10)| = |x + 10|$, and $d(x, -10) \geq 6$. So, $|x + 10| \geq 6$.

87. $d(y, 0) = |y - 0| = |y|$ and $d(y, 0) \geq 6$
Thus, $|y| \geq 6$.

88. $d(y, a) = |y - a|$ and $d(y, a) \leq 3$, So, $|y - a| \leq 3$.

		Receipts	*Expenditures*	$\lvert$*Receipts* − *Expenditures*$\rvert$
89.	1992	\$1091.2 billion	\$1381.5 billion	\$290.3 billion
90.	1996	\$1453.1 billion	\$1560.5 billion	\$107.4 billion
91.	2000	\$2025.2 billion	\$1789.0 billion	\$236.2 billion
92.	2004	\$1880.1 billion	\$2292.8 billion	\$412.7 billion
93.	2008	\$2524.0 billion	\$2982.5 billion	\$458.5 billion
94.	2012	\$2450.2 billion	\$3537.1 billion	\$1086.9 billion

95.

Budgeted Expense, b	*Actual Expense*, a	$\lvert a - b \rvert$	$0.05b$
\$112,700	\$113,356	\$656	\$5635

The actual expense difference is greater than \$500 (but is less than 5% of the budget) so it does not pass the "budget variance test."

96.

Budgeted Expense, b	*Actual Expense*, a	$\lvert a - b \rvert$	$0.05b$
\$9400	\$9772	\$372	$0.05(\$9400) = \$470$

Because the difference between the actual expenses and the budget is less than \$500 and less than 5% of the budgeted amount, there is compliance with the "budget variance test."

97.

Budgeted Expense, b	*Actual Expense*, a	$\lvert a - b \rvert$	$0.05b$
\$37,600	\$37,335	\$265	\$1880

Because the difference between the actual expenses and the budget is less than \$500 and less than 5% of the budgeted amount, there is compliance with the "budget variance test."

98.

Budgeted Expense, b	*Actual Expense*, a	$\lvert a - b \rvert$	$0.05b$
\$25,800	\$25,263	\$537	$0.05(25{,}800) = \$1290$

The actual expense difference is greater than \$500 (but is less than 5% of the budget) so it does not meet the "budget variance test."

99. $7x + 4$
Terms: $7x$, 4
Coefficient of $7x$: 7

100. $2x - 9$
Terms: $2x$, -9
Coefficient of $2x$: 2

101. $\sqrt{3}x^2 - 8x - 11$
Terms: $\sqrt{3}x^2$, $-8x$, -11
Coefficient of $\sqrt{3}x^2$: $\sqrt{3}$
Coefficient of $-8x$: -8

102. $7\sqrt{5}x^2 + 3$
Terms: $7\sqrt{5}x^2$, 3
Coefficient of $7\sqrt{5}x^2$: $7\sqrt{5}$

103. $4x^3 + \frac{x}{2} - 5$
Terms: $4x^3$, $\frac{x}{2}$, -5
Coefficient of $4x^3$: 4
Coefficient of $\frac{x}{2}$: $\frac{1}{2}$

104. $3x^4 + \frac{2x^3}{5}$
Terms: $3x^4$, $\frac{2}{5}x^3$
Coefficient of $3x^4$: 3
Coefficient of $\frac{2}{5}x^3$: $\frac{2}{5}$

105. $2x-5$

(a) $2(4)-5=8-5=3$

(b) $2\left(-\frac{1}{2}\right)-5=-1-5=-6$

106. $4-3x$

(a) $4-3(2)=4-6=-2$

(b) $4-3\left(-\frac{5}{6}\right)=4+\frac{15}{6}=4+\frac{5}{2}=\frac{13}{2}$

107. x^2-4

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

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

108. $\dfrac{x^2}{x+4}$

(a) $\dfrac{(1)^2}{1^2+4}=\dfrac{1}{1+4}=\dfrac{1}{5}$

(b) $\dfrac{(-4)^2}{-4+4}=\dfrac{16}{0}$, undefined

Division by zero is undefined.

109. $2(x+3)=2x+6$

Distributive Property

110. $(z-2)+0=z-2$

Additive Identity Property

111. $x+9=9+x$

Commutative Property of Addition

112. $\dfrac{1}{(h+6)}(h+6)=1,\ h\neq -6$

Multiplicative Inverse Property

113. $-y+(y+10)=(-y+y)+10=10$

Associative Property of Addition

114. $\frac{1}{7}(7\cdot 12)=\left(\frac{1}{7}\cdot 7\right)12$ Associative Property of Multiplication

$=1\cdot 12$ Multiplicative Inverse Property

$=12$ Multiplicative Identity Property

115. $\frac{3}{16}+\frac{5}{16}=\frac{8}{16}=\frac{1}{2}$

116. $\frac{6}{7}-\frac{5}{7}=\frac{1}{7}$

117. $\frac{5}{8}-\frac{5}{12}+\frac{1}{6}=\frac{15}{24}-\frac{10}{24}+\frac{4}{24}=\frac{9}{24}=\frac{3}{8}$

118. $\frac{10}{11}+\frac{6}{33}-\frac{13}{66}=\frac{60}{66}+\frac{12}{66}-\frac{13}{66}=\frac{59}{66}$

119. $\dfrac{x}{6}+\dfrac{4x}{12}=\dfrac{x}{6}+\dfrac{2x}{6}=\dfrac{3x}{6}=\dfrac{x}{2}$

120. $\dfrac{2x}{5}+\dfrac{x}{2}=\dfrac{4x}{10}+\dfrac{5x}{10}=\dfrac{9x}{10}$

121. $\dfrac{12}{x}\div\dfrac{1}{8}=\dfrac{12}{x}\cdot\dfrac{8}{1}=\dfrac{96}{x}$

122. $\dfrac{11}{x}\div\dfrac{3}{4}=\dfrac{11}{x}\cdot\dfrac{4}{3}=\dfrac{44}{3x}$

123. $\left(\frac{2}{5}\div 4\right)-\left(4\cdot\frac{3}{8}\right)=\left(\frac{2}{5}\cdot\frac{1}{4}\right)-\frac{12}{8}=\frac{1}{10}-\frac{3}{2}$

$=\frac{1}{10}-\frac{15}{10}=-\frac{14}{10}=-\frac{7}{5}$

124. $\left(\frac{3}{5}\div 3\right)-\left(6\cdot\frac{4}{8}\right)=\left(\frac{3}{5}\cdot\frac{1}{3}\right)-(3)$

$=\frac{1}{5}-3=\frac{1}{5}-\frac{15}{5}=-\frac{14}{5}$

125. $d(57,\ 236)=|236-57|$

$=179$ miles

126. $|60^\circ-23^\circ|=37^\circ$ change

127. False. The number 0 is nonnegative but positive.

128. False. If $a>0$ and $b<0$, then $ab<0$.

129. False. For example, $3>2$, but $\frac{1}{3}<\frac{1}{2}$.

130. (a)

n	1	0.5	0.01	0.0001	0.000001
$5/n$	5	10	500	50,000	5,000,000

(b) As n approaches 0, $5/n$ approaches infinity (∞). That is, $5/n$ increases without bound.

131. (a) $-A$ is negative, $-A<0$, because $A>0$.

(b) $-C$ is positive, $-C>0$ because $C<0$.

(c) $B-A$ is negative, $B-A<0$, because $B<0$ and $-A<0$.

(d) $A-C$ is positive, $A-C>0$ because $-C>0$ and $A>0$.

132. (a) Matches graph (ii).

(b) Matches graph (i).

A range of prices can only include zero and positive numbers with at most two decimal places. So, a range of prices can be represented by whole numbers and some noninteger positive fractions.

A range of lengths can only include positive numbers. So, a range of lengths can be represented by positive real numbers.

133. When u and v have the same sign, $|u+v| = |u| + |v|$. For example if $u = 2$ and $v = 1$, then $|2+1| = |2| + |1|$, or if $u = -2$ and $v = -1$, then $|-2+(-1)| = |-2| + |-1|$.

If u and v have different signs, then $|u+v| < |u| + |v|$.

For example if $u = 2$ and $v = -1$, $|2+(-1)| < |2| + |-1|$.

Finally, $|u+v| \ngeq |u| + |v|$, no matter the signs of u and v.

134. $a \leq 0$; If the original value of a is negative, then $|a|$ results in a positive number. Because a is negative, the expression $|a| = a$ states that $|a|$ is equal to a negative number, which can never happen. So, if a is originally negative, $|a|$ must equal $-a$, which is a positive value.

Section P. 2 Exponents and Radicals

1. exponent, base

2. square root

3. principal nth root

4. index, radicand

5. rationalizing

6. power, index

7. The conjugate of $2+3\sqrt{5}$ is $2-3\sqrt{5}$.

8. An expression involving radicals is in simplest form when the following conditions are satisfied:

1. All possible factors have been removed from the radical.
2. All fractions have radical-free denominators.
3. The index of the radical is reduced.

9. No, -10.767×10^3 is not written in scientific notation. It should be -1.0767×10^4.

10. 64 is both a perfect square $\left(8^2 = 64\right)$ and a perfect cube $\left(4^3 = 64\right)$.

11. (a) $3 \cdot 3^3 = 3^4 = 81$

(b) $\dfrac{3^2}{3^4} = \dfrac{1}{3^2} = \dfrac{1}{9}$

12. (a) $\dfrac{5^3}{5^2} = 5^1 = 5$

(b) $4^2 \cdot 4^2 = 4^4 = 256$

13. (a) $\left(4^3\right)^0 = 4^0 = 1$

(b) $\dfrac{6}{6^{-3}} = 6^4 = 1296$

14. (a) $24(-2)^{-5} = \dfrac{24}{(-2)^5} = \dfrac{24}{-32} = -\dfrac{3}{4}$

(b) $-7^0 = -1$

15. (a) $(4 \cdot 3)^3 = 12^3 = 1728$

(b) $\left(-3^2\right)^3 = (-9)^3 = -729$

16. (a) $\left(2^3 \cdot 3^2\right)^2 = (8 \cdot 9)^2 = (72)^2 = 5184$

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

17. (a) $2^{-1} + 3^{-1} = \dfrac{1}{2} + \dfrac{1}{3} = \dfrac{3}{6} + \dfrac{2}{6} = \dfrac{5}{6}$

(b) $\left(3^{-1}\right)^{-3} = 3^3 = 27$

18. (a) $\dfrac{4 \cdot 3^{-2}}{2^{-2} \cdot 3^{-1}} = \dfrac{4\left(\frac{1}{9}\right)}{\left(\frac{1}{4}\right)\left(\frac{1}{3}\right)} = \dfrac{\frac{4}{9}}{\frac{1}{12}} = \dfrac{4}{9} \cdot \dfrac{12}{1} = \dfrac{48}{9} = \dfrac{16}{3}$

(b) $3^{-1} + 2^{-2} = \dfrac{1}{3} + \dfrac{1}{4} = \dfrac{4+3}{12} = \dfrac{7}{12}$

19. When $x = -3$,
$2x^3 = 2(-3)^3 = 2(-27) = -54$.

20. When $x = 2$, $-3x^4 = -3(2)^4 = -3(16) = -48$.

21. When $x = 4$, $5(-x)^0 = 5(-4)^0 = 5(1) = 5$.

22. When $x = 7$,
$6x^0 - (6x)^0 = 6(7)^0 - (6 \cdot 7)^0 = 6(1) - 1 = 5.$

23. When $x = 2$, $7x^{-2} = 7\left(2^{-2}\right) = 7\left(\frac{1}{2^2}\right) = \frac{7}{4}.$

24. When $x = -5$, $20x^{-2} + x^{-1} = 20(-5)^{-2} + (-5)^{-1} = 20\left(\frac{1}{25}\right) + \frac{1}{-5} = \frac{4}{5} - \frac{1}{5} = \frac{3}{5}.$

25. (a) $x^3\left(x^2\right) = x^5$

(b) $x^4\left(3x^5\right) = 3x^9$

26. (a) $4z^4\left(-2z^3\right) = -8z^7$

(b) $-5x^3\left(4x^2\right) = -20x^5$

27. (a) $(3x)^2 = 3^2x^2 = 9x^2$

(b) $\left(4x^3\right)^0 = 1, x \neq 0$

28. (a) $6z^2\left(2z^5\right)^4 = 6z^2\left(16z^{20}\right) = 96z^{22}$

(b) $\left(3x^5\right)^3\left(2x^7\right)^2 = \left(27x^{15}\right)\left(4x^{14}\right) = 108x^{29}$

29. (a) $\frac{7x^2}{x^3} = 7x^{2-3} = 7x^{-1} = \frac{7}{x}$

(b) $\frac{12(x+y)^3}{9(x+y)} = \frac{4}{3}(x+y)^{3-1}$

$= \frac{4}{3}(x+y)^2, x+y \neq 0$

30. (a) $\frac{r^5}{r^9} = \frac{1}{r^4}$

(b) $\frac{3x^2y^4}{15(xy)^2} = \frac{3x^2y^4}{15x^2y^2} = \frac{y^2}{5}, x \neq 0, y \neq 0$

31. (a) $\left[\left(x^2y^{-2}\right)^{-1}\right]^{-1} = x^2y^{-2} = \frac{x^2}{y^2}, x \neq 0$

(b) $\left(\frac{a^{-2}}{b^{-2}}\right)\left(\frac{b}{a}\right)^3 = \frac{b^2}{a^2} \cdot \frac{b^3}{a^3} = \frac{b^5}{a^5}, b \neq 0$

32. (a) $\left(\frac{4}{y}\right)^3\left(\frac{3}{y}\right)^4 = \left(\frac{64}{y^3}\right)\left(\frac{81}{y^4}\right) = \frac{5184}{y^7}$

(b) $\left(5x^2z^6\right)^3\left(5x^2z^6\right)^{-3} = 1, x \neq 0, z \neq 0$

33. $(-4)^3\left(5^2\right) = (-64)(25)$

$= -1600$

34. $\left(8^{-4}\right)\left(10^3\right) \approx 0.244$

35. $\frac{3^6}{7^3} = \frac{729}{343} \approx 2.125$

36. $\frac{4^5}{9^3} = \frac{1024}{729} \approx 1.405$

37. $\frac{4^3 - 1}{3^{-4}} = 3^4(64 - 1) = (81)(63) = 5103$

38. $\frac{3^2 - 2}{4^2 - 3} = \frac{9 - 2}{16 - 3} = \frac{7}{13} \approx 0.538$

39. $973.50 = 9.735 \times 10^2$

40. $28{,}022.2 = 2.80222 \times 10^4$

41. $10{,}252.484 = 1.0252484 \times 10^4$

42. $525{,}252{,}118 = 5.25252118 \times 10^8$

43. $-1110.25 = -1.11025 \times 10^3$

44. $-5{,}222{,}145 = -5.222145 \times 10^6$

45. $0.0002485 = 2.485 \times 10^{-4}$

46. $0.0000025 = 2.5 \times 10^{-6}$

47. $-0.0000025 = -2.5 \times 10^{-6}$

48. $-0.000125005 = -1.25005 \times 10^{-4}$

49. $57{,}300{,}000 = 5.73 \times 10^7$ square miles

50. $9{,}460{,}000{,}000{,}000 = 9.46 \times 10^{12}$ kilometers

51. $0.0000899 = 8.99 \times 10^{-5}$ gram per cm^3

52. 0.000003281 foot $= 3.281 \times 10^{-6}$ foot

53. $1.08 \times 10^4 = 10{,}800$

54. $-4.816 \times 10^8 = -481{,}600{,}000$

55. $-7.65 \times 10^{-7} = -0.000000765$

56. $5.098 \times 10^{-10} = 0.0000000005098$

57. $5.14 \times 10^2 = 514$

58. $1.5 \times 10^7 = 15{,}000{,}000$ degrees Celsius

59. $9.0 \times 10^{-5} = 0.00009$ meter

60. 1.6022×10^{-19}
$= 0.00000000000000000016022$ coulomb

61. $(2.0\times10^{7})(3.0\times10^{-3}) = 6.0\times10^{4} = 60{,}000$

62. $(1.4\times10^{5})(5.2\times10^{-2}) = (1.4)(5.2)\times10^{3}$
$= 7.28\times10^{3} = 7280$

63. $\dfrac{7.0\times10^{5}}{4.0\times10^{-3}} = \dfrac{7.0}{4.0}\times10^{8} = 1.75\times10^{8} = 175{,}000{,}000$

64. $\dfrac{3.0\times10^{-3}}{6.0\times10^{2}} = \dfrac{3.0}{6.0}\times10^{-5} = 0.5\times10^{-5} = 5.0\times10^{-6}$
$= 0.000005$

65. $\sqrt{25\times10^{8}} = \sqrt{5^{2}\times(10^{4})^{2}} = 5\times10^{4} = 50{,}000$

66. $\sqrt[3]{8\times10^{15}} = \sqrt[3]{2^{3}\times(10^{5})^{3}}$
$= 2\times10^{5}$
$= 200{,}000$

67. (a) $(9.3\times10^{6})^{3}(6.1\times10^{-4}) \approx 4.907\times10^{17}$

(b) $\dfrac{(2.414\times10^{4})^{6}}{(1.68\times10^{5})^{5}} \approx 1.479$

68. (a) $750\left(1+\dfrac{0.11}{365}\right)^{800} \approx 954.448$

(b) $\dfrac{67{,}000{,}000 + 93{,}000{,}000}{0.0052}$
$\approx 30{,}769{,}230{,}769.2 \approx 3.077\times10^{10}$

69. (a) $\sqrt{4.5\times10^{9}} \approx 67{,}082.039$

(b) $(7.3\times10^{4})^{1/5} \approx 9.390$

70. (a) $(2.65\times10^{-4})^{1/3} \approx 0.064$

(b) $\sqrt[4]{9.9\times10^{6}} \approx 56.093$

71. $\sqrt{121} = \sqrt{11^{2}} = 11$

72. $\sqrt{-49}$ is not possible. Not a real number.

73. $-\sqrt[3]{-64} = -\sqrt[3]{(-4)^{3}} = -(-4) = 4$

74. $\sqrt[3]{125} = 5$

75. $\sqrt[4]{-625}$ is not possible. Not a real number.

76. $-\sqrt[7]{-128} = -(-2) = 2$

77. $-\sqrt[6]{\dfrac{1}{729}} = -\dfrac{1}{3}$

78. $\dfrac{\sqrt[5]{-243}}{9} = \dfrac{-3}{9} = -\dfrac{1}{3}$

79. $\sqrt[3]{45^{2}} \approx 12.651$

80. $\sqrt[5]{-27^{3}} = (-27)^{3/5} \approx -7.225$

81. $(6.1)^{-2.9} \approx 0.005$

82. $(3.4)^{2.5} \approx 21.316$

83. $\sqrt[4]{90} - (4.1^{3})\sqrt{17} \approx -281.088$

84. $(1.2^{-2})\sqrt{75} + 3\sqrt{8} \approx 14.499$

85. $\dfrac{-5+\sqrt{33}}{5} \approx 0.149$

86. $\dfrac{\sqrt[3]{-68} + 4}{0.1} \approx -0.817$

87. $\dfrac{3.14}{\pi} + \sqrt[3]{5} \approx 2.709$

88. $\dfrac{\sqrt{10}}{2.5} - \pi^{2} \approx -8.605$

89. $(2.8)^{-2} + 1.01\times10^{6} \approx 1{,}010{,}000.128$

90. $2.12\times10^{-2} + \sqrt{15} \approx 3.894$

91. $\left(\sqrt[3]{20}\right)^{3} = 20$

92. $\sqrt[4]{(-3x)^{4}} = 3|x|$

93. $\sqrt{12}\cdot\sqrt{3} = \sqrt{36} = 6$

94. $\dfrac{\sqrt[3]{40x^{5}}}{\sqrt[3]{5x^{2}}} = \sqrt[3]{\dfrac{40x^{5}}{5x^{2}}} = \sqrt[3]{8x^{3}} = 2x$

95. (a) $\sqrt{45} = \sqrt{9\cdot5} = 3\sqrt{5}$

(b) $\sqrt[3]{\dfrac{32a^{2}}{b^{2}}} = \left(\dfrac{2^{3}\cdot2^{2}a^{2}}{b^{2}}\right)^{1/3} = 2\sqrt[3]{\dfrac{4a^{2}}{b^{2}}}$

96. (a) $\sqrt[3]{54} = \sqrt[3]{3^{3}\cdot2} = 3\sqrt[3]{2}$

(b) $\sqrt{32x^{3}y^{4}} = \sqrt{2^{4}\cdot2\cdot x\cdot x^{2}\cdot(y^{2})^{2}} = 4xy^{2}\sqrt{2x}$

97. (a) $\sqrt[3]{16x^5} = \sqrt[3]{8 \cdot 2 \cdot x^3 \cdot x^2} = 2x^3\sqrt[3]{2x^2}$

(b) $\sqrt{75x^2y^{-4}} = \sqrt{\dfrac{25 \cdot 3 \cdot x^2}{y^4}} = \dfrac{5x\sqrt{3}}{y^2}$

98. (a) $\sqrt[4]{3x^4y^2} = |x|\sqrt[4]{3y^2}$

(b) $\sqrt[5]{160x^8z^4} = \sqrt[5]{32 \cdot 5 \cdot x^5 \cdot x^3 \cdot z^4} = 2x\sqrt[5]{5x^3z^4}$

99. (a) $2\sqrt{50} + 12\sqrt{8} = 2\sqrt{25 \cdot 2} + 12\sqrt{4 \cdot 2}$
$= 2\left(5\sqrt{2}\right) + 12\left(2\sqrt{2}\right)$
$= 10\sqrt{2} + 24\sqrt{2}$
$= 34\sqrt{2}$

(b) $10\sqrt{32} - 6\sqrt{18} = 10\sqrt{16 \cdot 2} - 6\sqrt{9 \cdot 2}$
$= 10\left(4\sqrt{2}\right) - 6\left(3\sqrt{2}\right)$
$= 40\sqrt{2} - 18\sqrt{2}$
$= 22\sqrt{2}$

100. (a) $5\sqrt{x} - 3\sqrt{x} = 2\sqrt{x}$

(b) $-2\sqrt{9y} + 10\sqrt{y} = -2\sqrt{3^2 \cdot y} + 10\sqrt{y}$
$= -6\sqrt{y} + 10\sqrt{y} = 4\sqrt{y}$

101. (a) $3\sqrt{x+1} + 10\sqrt{x+1} = 13\sqrt{x+1}$

(b) $7\sqrt{80x} - 2\sqrt{125x} = 7\sqrt{16 \cdot 5x} - 2\sqrt{25 \cdot 5x}$
$= 7(4)\sqrt{5x} - 2(5)\sqrt{5x}$
$= 28\sqrt{5x} - 10\sqrt{5x}$
$= 18\sqrt{5x}$

102. (a) $5\sqrt{10x^2} - \sqrt{90x^2} = 5\sqrt{10x^2} - \sqrt{3^2 \cdot 10 \cdot x^2}$
$= 5\sqrt{10x^2} - 3\sqrt{10x^2}$
$= 2\sqrt{10x^2} = 2|x|\sqrt{10}$

(b) $8\sqrt[3]{27x} - \frac{1}{2}\sqrt[3]{64x} = 8\left(3^3 \cdot x\right)^{1/3} - \frac{1}{2}\left(4^3 \cdot x\right)^{1/3}$
$= 24x^{1/3} - 2x^{1/3}$
$= 22x^{1/3} = 22\sqrt[3]{x}$

103. $\sqrt{\dfrac{3}{11}} = \dfrac{\sqrt{3}}{\sqrt{11}}$

104. $\sqrt{5} + \sqrt{3} \approx 3.968$ and $\sqrt{5+3} = \sqrt{8} \approx 2.828$

Thus, $\sqrt{5} + \sqrt{3} > \sqrt{5+3}$.

105. $\sqrt{3^2 + 2^2} = \sqrt{9+4} = \sqrt{13} \approx 3.606$

Thus, $5 > \sqrt{3^2 + 2^2}$.

106. $\sqrt{3^2 + 4^2} = \sqrt{9+16} = \sqrt{25} = 5$

So, $5 = \sqrt{3^2 + 4^2}$.

107. $\dfrac{1}{\sqrt{3}} = \dfrac{1}{\sqrt{3}} \cdot \dfrac{\sqrt{3}}{\sqrt{3}} = \dfrac{\sqrt{3}}{3}$

108. $\dfrac{8}{\sqrt[3]{2}} = \dfrac{8}{\sqrt[3]{2}} \cdot \dfrac{\sqrt[3]{4}}{\sqrt[3]{4}} = \dfrac{8\sqrt[3]{4}}{2} = 4\sqrt[3]{4}$

109. $\dfrac{5}{\sqrt{14}-2} = \dfrac{5}{\sqrt{14}-2} \cdot \dfrac{\sqrt{14}+2}{\sqrt{14}+2}$
$= \dfrac{5\left(\sqrt{14}+2\right)}{14-4}$
$= \dfrac{5\left(\sqrt{14}+2\right)}{10}$
$= \dfrac{\sqrt{14}+2}{2}$

110. $\dfrac{3}{\sqrt{5}+\sqrt{6}} = \dfrac{3}{\sqrt{5}+\sqrt{6}} \cdot \dfrac{\sqrt{5}-\sqrt{6}}{\sqrt{5}-\sqrt{6}}$
$= \dfrac{3\left(\sqrt{5}-\sqrt{6}\right)}{5-6}$
$= 3\left(\sqrt{6}-\sqrt{5}\right)$

111. $\dfrac{\sqrt{12}}{2} = \dfrac{2\sqrt{3}}{2} = \sqrt{3} = \dfrac{\sqrt{3} \cdot \sqrt{3}}{1 \cdot \sqrt{3}} = \dfrac{3}{\sqrt{3}}$

112. $\dfrac{\sqrt{3}}{3} \cdot \dfrac{\sqrt{3}}{\sqrt{3}} = \dfrac{3}{3\sqrt{3}} = \dfrac{1}{\sqrt{3}}$

113. $\dfrac{\sqrt{5}+\sqrt{3}}{3} = \dfrac{\sqrt{5}+\sqrt{3}}{3} \cdot \dfrac{\sqrt{5}-\sqrt{3}}{\sqrt{5}-\sqrt{3}}$
$= \dfrac{5-3}{3\left(\sqrt{5}-\sqrt{3}\right)}$
$= \dfrac{2}{3\left(\sqrt{5}-\sqrt{3}\right)}$

114. $\dfrac{\sqrt{7}-3}{4} = \dfrac{\sqrt{7}-3}{4} \cdot \dfrac{\sqrt{7}+3}{\sqrt{7}+3}$
$= \dfrac{7-9}{4\left(\sqrt{7}+3\right)} = \dfrac{-1}{2\left(\sqrt{7}+3\right)}$
$= \dfrac{-1}{2\sqrt{7}+6}$

115. (a) $\sqrt[4]{3^2} = 3^{2/4} = 3^{1/2} = \sqrt{3}$

(b) $\sqrt[6]{(x+1)^4} = (x+1)^{4/6} = (x+1)^{2/3}$
$= \sqrt[3]{(x+1)^2}$

116. (a) $\sqrt[6]{x^3} = x^{3/6} = x^{1/2} = \sqrt{x}$

(b) $\sqrt[4]{(3x^2)^4} = 3x^2$

	Radical Form	*Rational Exponent Form*
117.	$\sqrt[3]{64}$ Given	$64^{1/3}$ Answer
118.	$-\sqrt{144}$ Answer	$-(144^{1/2})$ Given
119.	$\sqrt[5]{\frac{1}{32}}$ Answer	$(1/32)^{1/5}$ Given
120.	$\sqrt[3]{614.125}$ Given	$(614.125)^{1/3}$ Answer
121.	$\sqrt[5]{-243}$ Answer	$(-243)^{1/5}$ Given
122.	$\sqrt[3]{-216}$ Given	$(-216)^{1/3}$ Answer
123.	$\sqrt[4]{81^3}$ Given	$81^{3/4}$ Answer
124.	$\sqrt[4]{16^5}$ Answer	$16^{5/4}$ Given

125. $\dfrac{(2x^2)^{3/2}}{2^{1/2}x^4} = \dfrac{2^{3/2}(x^2)^{3/2}}{2^{1/2}x^4} = \dfrac{2^{3/2}x^3}{2^{1/2}x^4}$
$= 2^{3/2-1/2}x^{3-4} = 2^1x^{-1} = \dfrac{2}{|x|}$

126. $\dfrac{x^{4/3}y^{2/3}}{(xy)^{1/3}} = \dfrac{x^{4/3}y^{2/3}}{x^{1/3}y^{1/3}} = x^{(4/3)-(1/3)}y^{(2/3)-(1/3)}$
$= xy^{1/3},\ x \neq 0,\ y \neq 0$

127. $\dfrac{x^{-3}\cdot x^{1/2}}{x^{3/2}\cdot x^{-1}} = \dfrac{x^{1/2}\cdot x^1}{x^{3/2}\cdot x^3} = x^{(1/2)+1-(3/2)-3}$
$= x^{-3} = \dfrac{1}{x^3},\ x > 0$

128. $\dfrac{5^{-1/2}\cdot 5x^{5/2}}{(5x)^{3/2}} = \dfrac{5^{-1/2}\cdot 5x^{5/2}}{5^{3/2}x^{3/2}} = 5^{-1}x = \dfrac{x}{5},\ x > 0$

129. $32^{-3/5} = \dfrac{1}{32^{3/5}} = \dfrac{1}{\left(\sqrt[5]{32}\right)^3} = \dfrac{1}{(2)^3} = \dfrac{1}{8}$

130. $\left(\dfrac{9}{4}\right)^{-1/2} = \left(\dfrac{4}{9}\right)^{1/2} = \dfrac{4^{1/2}}{9^{1/2}} = \dfrac{2}{3}$

131. $\left(-\dfrac{1}{27}\right)^{-1/3} = (-27)^{1/3} = \sqrt[3]{-27} = \sqrt[3]{(-3)^3} = -3$

132. $-\left(\frac{1}{125}\right)^{-4/3} = -(125)^{4/3}$
$= -\left(125^{1/3}\right)^4 = -(5)^4 = -625$

133. $\sqrt{\sqrt{35}} = \left(35^{1/2}\right)^{1/2} = 35^{1/4} = \sqrt[4]{35}$

134. $\sqrt{\sqrt[4]{2x}} = \left((2x)^{1/4}\right)^{1/2} = (2x)^{1/8} = \sqrt[8]{2x}$

135. $\sqrt{\sqrt{243(x+1)}} = \left(\left[243(x+1)\right]^{1/2}\right)^{1/2}$
$= \left(243(x+1)\right)^{1/4}$
$= \sqrt[4]{243(x+1)}$
$= \sqrt[4]{3\cdot 3^4(x+1)}$
$= 3\sqrt[4]{3(x+1)}$

136. $\sqrt{\sqrt[3]{128a^7b}} = \left[\left(128a^7b\right)^{1/3}\right]^{1/2} = \left(128a^7b\right)^{1/6} = \sqrt[6]{128a^7b} = \sqrt[6]{64\cdot 2\cdot a^6\cdot a\cdot b} = 2a\sqrt[6]{2ab}$

137. Brazil: $\dfrac{2.19 \times 10^{12}}{2.01 \times 10^{8}} = 1.09 \times 10^{4}$

Canada: $\dfrac{1.83 \times 10^{12}}{3.46 \times 10^{7}} = 5.29 \times 10^{4}$

Germany: $\dfrac{3.59 \times 10^{12}}{8.11 \times 10^{7}} = 4.43 \times 10^{4}$

India: $\dfrac{1.76 \times 10^{12}}{1.22 \times 10^{9}} = 1.44 \times 10^{3}$

Iran: $\dfrac{4.12 \times 10^{11}}{7.99 \times 10^{7}} = 5.16 \times 10^{3}$

Ireland: $\dfrac{2.21 \times 10^{11}}{4.78 \times 10^{6}} = 4.62 \times 10^{4}$

Mexico: $\dfrac{1.33 \times 10^{12}}{1.19 \times 10^{8}} = 1.12 \times 10^{4}$

138. Paper: $0.274\left(2.51 \times 10^{8}\right) \approx 6.8774 \times 10^{7}$ tons

Metals: $0.089\left(2.51 \times 10^{8}\right) \approx 2.2339 \times 10^{7}$ tons

Glass: $0.046\left(2.51 \times 10^{8}\right) \approx 1.1546 \times 10^{7}$ tons

Plastics: $0.127\left(2.51 \times 10^{8}\right) \approx 3.1877 \times 10^{7}$ tons

Yard waste: $0.135\left(2.51 \times 10^{8}\right) \approx 3.3885 \times 10^{7}$ tons

Other: $0.329\left(2.51 \times 10^{8}\right) \approx 8.2579 \times 10^{7}$ tons

139. For $h = 7$,

$$t = 0.03\left[12^{5/2} - (12-7)^{5/2}\right] = 0.03\left[12^{5/2} - 5^{5/2}\right]$$

≈ 13.288 seconds.

140. True. For $x \neq 0$, $\dfrac{x^{k+1}}{x} = \dfrac{x^{k+1}}{x^{1}} = x^{k}$.

141. False. For example, let $a = 2$, $n = 3$ and $k = 2$. Then $\left(a^{n}\right)^{k} = \left(2^{3}\right)^{2} = 8^{2} = 64$, whereas $a^{(n^{k})} = 2^{(3^{2})} = 2^{9} = 512$.

142. False. For example, let $a = 5$ and $b = 4$.

$(a + b)^2 = (5 + 4)^2 = 9^2 = 81$, whereas

$(5)^2 + (4)^2 = 25 + 16 = 41$.

143. True.

$$x^{-1} + y^{-1} = \frac{1}{x} + \frac{1}{y}$$

$$= \frac{y}{xy} + \frac{x}{xy}$$

$$= \frac{y + x}{xy}$$

$$= \frac{x + y}{xy}$$

144. The length of a side of package A is about 8 inches $\left(8^3 = 512\right)$, and the length of a side of package B is about 6.3 inches $\left(6.3^3 \approx 250\right)$. Twice the length of a side of package B is about $2(6.3) = 12.6$ inches, and $8 < 12.6$. So, the length x of a side of package A is less than twice the length of a side of package B.

145. For $a \neq 0$, $1 = \dfrac{a}{a} = \dfrac{a^{1}}{a^{1}} = a^{1-1} = a^{0}$.

Thus, $a^{0} = 1$.

146. Consider $x^2 = n$, x a positive integer.

Unit digit of x	*Unit digit of* $n = x^2$
1	1
2	4
3	9
4	6
5	5
6	6
7	9
8	4
9	1
0	0

Therefore, the possible digits are 0, 1, 4, 5, 6, and 9 thus $\sqrt{5233}$ is *not* an integer because its unit digit is 3.

147. No. Rationalizing the denominator produces a number equivalent to the original fraction; squaring does not.

$$\left(\frac{5}{\sqrt{3}}\right)^{2} = \frac{25}{3} \neq \frac{5}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{5\sqrt{3}}{3}$$

Section P.3 Polynomials and Factoring

1. n, a_n

2. monomial

3. First, Outer, Inner, Last

4. prime

5. A polynomial is completely factorial when each of its factors are prime.

6. Four guidelines for factoring polynomials are as follows:
(1) Factor out any common factors using the Distributive Property.
(2) Factor according to one of the special polynomial forms.
(3) Factor as $ax^2 + bx + c = (mx + r)(nx + s)$.
(4) Factor by grouping.

7. 7 is a polynomial of degree zero. Matches (d).

8. $-3x^5 + 2x^3 + x$ is a trinomial of degree 5. Matches (e).

9. $-4x^3 + 1$ is a binomial with leading coefficient -4. Matches (b).

10. $6x$ is a monomial of positive degree. Matches (a).

11. $\frac{3}{4}x^4 + x^2 + 14$ is a trinomial with leading coefficient $\frac{3}{4}$. Matches (f).

12. $x^3 + 2x^2 - 4x + 1$ is a third-degree polynomial with leading coefficient 1. Matches (c).

13. $-2x^3 + 4x$ is one possible answer.

14. $8x^5 + 14$ is one possible answer.

15. $-15x^4 + 2x$ is one possible answer.

16. $2x^3 + 4x + 2$ is one possible answer.

17. $3x + 4x^2 + 2 = 4x^2 + 3x + 2$ Standard form
Degree: 2
Leading coefficient: 4

18. $x^2 - 4 - 3x^4 = -3x^4 + x^2 - 4$ Standard form
Degree: 4
Leading coefficient: -3

19. $-8 + x^7 = x^7 - 8$ Standard form
Degree: 7
Leading coefficient: 1

20. $23 - x^3 = -x^3 + 23$ Standard form
Degree: 3
Leading coefficient: -1

21. $1 - x + 6x^4 - 2x^5 = -2x^5 + 6x^4 - x + 1$ Standard form
Degree: 5
Leading coefficient: -2

22. $-x^6 + 5 - 4x^5 + x^3 = -x^6 - 4x^5 + x^3 + 5$ Standard form
Degree: 6
Leading coefficient: -1

23. This is a polynomial: $-8y^2 + 2y$.

24. $5x^4 - 2x^2 + \dfrac{1}{x^2}$ is not a polynomial.

25. $\sqrt{x^2 - x^4}$ is not a polynomial.

26. $\dfrac{x^2 + 2x - 3}{6} = \dfrac{1}{6}x^2 + \dfrac{1}{3}x - \dfrac{1}{2}$ is a polynomial.

27. $(4x + 1) + (-x + 9) = 3x + 10$

28. $(t^2 - 3) + (6t^2 - 4t) = 7t^2 - 4t - 3$

29. $(8x + 5) - (6x - 12) = 8x + 5 - 6x + 12 = 2x + 17$

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

31. $(2x^3 - 9x^2 - 20) + (-2x^3 + 10x^2) = x^2 - 20$

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

33. $(15x^2 - 6) - (-8.1x^3 - 14.7x^2 - 17)$
$= 15x^2 - 6 + 8.1x^3 + 14.7x^2 + 17$
$= 8.1x^3 + 29.7x^2 + 11$

34. $(13.6w^4 - 14w - 17.4) - (16.9w^4 - 9.2w + 13) = 13.6w^4 - 14w - 17.4 - 16.9w^4 + 9.2w - 13 = 3.3w^4 - 4.8w - 30.4$

35. $5z(z - 8) = 5z^2 - 40z$

36. $(\frac{1}{6}x + 1)(2x^2) = \frac{1}{3}x^3 + 2x^2$

37. $\left(5 - \dfrac{3}{2}y\right)(-4y) = (5)(-4y) - \left(\dfrac{3}{2}y\right)(-4y)$
$= 6y^2 - 20y$

38. $-7x(4 - x^3) = -28x + 7x^4$
$= 7x^4 - 28x$

39. $3x(x^2 - 2x + 1) = 3x(x^2) + 3x(-2x) + 3x(1)$
$= 3x^3 - 6x^2 + 3x$

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

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

42. $(x-5)(x+10) = x^2 + 10x - 5x - 50$ FOIL
$= x^2 + 5x - 50$

43. $(3x-5)(2x+1) = 6x^2 + 3x - 10x - 5$ FOIL
$= 6x^2 - 7x - 5$

44. $(7x-2)(4x-3) = 28x^2 - 21x - 8x + 6$ FOIL
$= 28x^2 - 29x + 6$

45. $(4y + 7)^2 = 16y^2 + 56y + 49$

46. $(3a - 3)^2 = 9a^2 - 18a + 9$

47. $(2-5x)^2 = 4 - 2(2)(5x) + 25x^2$
$= 4 - 20x + 25x^2$
$= 25x^2 - 20x + 4$

48. $(5x+8y)^2 = 25x^2 + 2(5x)(8y) + 64y^2$
$= 25x^2 + 80xy + 64y^2$

49. $(x-9)(x+9) = x^2 - 9^2 = x^2 - 81$

50. $(5x+6)(5x-6) = (5x)^2 - 6^2 = 25x^2 - 36$

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

52. $(2r^2 - 5)(2r^2 + 5) = (2r^2)^2 - 5^2 = 4r^4 - 25$

53. $(x+1)^3 = x^3 + 3x^2(1) + 3x(1^2) + 1^3$
$= x^3 + 3x^2 + 3x + 1$

54. $(y-4)^3 = y^3 - 3y^2(4) + 3y(4)^2 - 4^3$
$= y^3 - 12y^2 + 48y - 64$

55. $(2x-y)^3 = (2x)^3 - 3(2x)^2 y + 3(2x)y^2 - y^3$
$= 8x^3 - 12x^2y + 6xy^2 - y^3$

56. $(3x+2y)^3 = (3x)^3 + 3(3x)^2(2y) + 3(3x)(2y)^2 + (2y)^3$
$= 27x^3 + 54x^2y + 36xy^2 + 8y^3$

57. $\left(\frac{1}{4}x - 3\right)\left(\frac{1}{4}x + 3\right) = \left(\frac{1}{4}x\right)^2 - 3^2 = \frac{1}{16}x^2 - 9$

58. $(1.5y + 0.6)(1.5y - 0.6) = 2.25y^2 - 0.36$

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

60. $(1.8y - 5)^2 = (1.8y)^2 + 2(1.8y)(-5) + (-5)^2$
$= 3.24y^2 - 18y + 25$

61.
$$\begin{array}{rrrrrrrr} & & & - & x^2 & + & x & - & 5 \\ & & & & 3x^2 & + & 4x & + & 1 \\ \hline & & & - & x^2 & + & x & - & 5 \\ & & - & 4x^3 & + & 4x^2 & - & 20x & \\ - & 3x^4 & + & 3x^3 & - & 15x^2 & & & \\ \hline - & 3x^4 & - & x^3 & - & 12x^2 & - & 19x & - & 5 \end{array}$$
Answer: $-3x^4 - x^3 - 12x^2 - 19x - 5$

62.
$$\begin{array}{rrrrrrrr} & & & x^2 & + & 3x & + & 2 \\ & & & 2x^2 & - & x & + & 4 \\ \hline & & & 4x^2 & + & 12x & + & 8 \\ & - & x^3 & - & 3x^2 & - & 2x & & \\ 2x^4 & + & 6x^3 & + & 4x^2 & & & & \\ \hline 2x^4 & + & 5x^3 & + & 5x^2 & + & 10x & + & 8 \end{array}$$

63. $[(x+z)+5][(x+z)-5] = (x+z)^2 - 5^2$
$= x^2 + 2xz + z^2 - 25$

64. $[(x-3y)+z][(x-3y)-z]$
$= (x-3y)^2 - z^2$
$= x^2 - 2x(3y) + (3y)^2 - z^2$
$= x^2 - 6xy + 9y^2 - z^2$

65. $[(x-3)+y]^2 = (x-3)^2 + 2y(x-3) + y^2$
$= x^2 - 6x + 9 + 2xy - 6y + y^2$
$= x^2 + 2xy + y^2 - 6x - 6y + 9$

66. $[(x+1)-y]^2 = (x+1)^2 + 2(x+1)(-y) + (-y)^2$
$= x^2 + 2x + 1 - 2xy - 2y + y^2$
$= x^2 - 2xy + y^2 + 2x - 2y + 1$

67. $5x - 40 = 5(x-8)$

68. $4y + 20 = 4(y+5)$

69. $2x^3 - 6x = 2x\left(x^2 - 3\right)$

70. $3z^4 - 6z^2 + 9z = 3z\left(z^3 - 2z + 3\right)$

71. $3x(x-5) + 8(x-5) = (3x+8)(x-5)$

72. $5(x+1) - x(x+1) = (x+1)(5-x)$
$= -(x+1)(x-5)$

73. $(5x-4)^2 + (5x-4) = (5x-4)\left[(5x-4)+1\right]$
$= (5x-4)(5x-3)$

74. $2x(x+3) - 3x(x+3)^2 = (x+3)\left[2x - 3x(x+3)\right] = (x+3)\left(2x - 3x^2 - 9x\right)$
$= (x+3)\left(-3x^2 - 7x\right)$
$= -x(x+3)(3x+7)$

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

76. $x^2 - 81 = (x+9)(x-9)$

77. $48y^2 - 27 = 3\left(16y^2 - 9\right) = 3\left((4y)^2 - 3^2\right)$
$= 3(4y+3)(4y-3)$

78. $50 - 98z^2 = 2\left(25 - 49z^2\right)$
$= 2\left(5^2 - (7z)^2\right)$
$= 2(5+7z)(5-7z)$
$= -2(7z+5)(7z-5)$

79. $4x^2 - \frac{1}{9} = (2x)^2 - \left(\frac{1}{3}\right)^2 = \left(2x + \frac{1}{3}\right)\left(2x - \frac{1}{3}\right)$

80. $\frac{25}{36}y^2 - 49 = \left(\frac{5}{6}y\right)^2 - 7^2 = \left(\frac{5}{6}y + 7\right)\left(\frac{5}{6}y - 7\right)$

81. $(x-1)^2 - 4 = \left[(x-1)+2\right]\left[(x-1)-2\right]$
$= (x+1)(x-3)$

82. $25 - (z+5)^2 = 5^2 - (z+5)^2$
$= \left(5 - (z+5)\right)\left(5 + (z+5)\right)$
$= (5 - z - 5)(5 + z + 5)$
$= -z(z+10)$

83. $x^2 - 4x + 4 = x^2 - 2(2)x + 2^2 = (x-2)^2$

84. $x^2 + 10x + 25 = x^2 + 2(5)(x) + 5^2 = (x+5)^2$

85. $x^2 + x + \frac{1}{4} = x^2 + 2\left(\frac{1}{2}\right)x + \left(\frac{1}{2}\right)^2 = \left(x + \frac{1}{2}\right)^2$

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

87. $4x^2 - 12x + 9 = (2x)^2 - 2(2x)(3) + 3^2$
$= (2x-3)^2$

88. $25z^2 - 10z + 1 = (5z)^2 - 2(5z)(1) + 1$
$= (5z-1)^2$

89. $4x^2 - \frac{4}{3}x + \frac{1}{9} = (2x)^2 - 2(2x)\left(\frac{1}{3}\right) + \left(\frac{1}{3}\right)^2$
$= \left(2x - \frac{1}{3}\right)^2$

90. $9y^2 - \frac{3}{2}y + \frac{1}{16} = (3y)^2 - 2(3y)\left(\frac{1}{4}\right) + \left(\frac{1}{4}\right)^2$
$= \left(3y - \frac{1}{4}\right)^2$
$= \frac{(12y-1)^2}{16}$

91. $x^3 - 8 = (x)^3 - (2)^3$
$= (x-2)\left(x^2 + 2x + 4\right)$

92. $y^3 - 125 = (y)^3 - (5)^3$
$= (y-5)\left(y^2 + 5y + 25\right)$

93. $z^3 + 1 = (z)^3 + (1)^3$
$= (z+1)\left(z^2 - z + 1\right)$

94. $x^3 + 64 = (x)^3 + (4)^3$
$= (x+4)\left(x^2 - 4x + 16\right)$

95. $x^3 + \frac{1}{27} = (x)^3 + \left(\frac{1}{3}\right)^3$
$= \left(x + \frac{1}{3}\right)\left(x^2 - \frac{1}{3}x + \frac{1}{9}\right)$

96. $w^3 - \dfrac{27}{216} = w^3 - \dfrac{1}{8} = (w)^3 - \left(\dfrac{1}{2}\right)^3$
$= \left(w - \dfrac{1}{2}\right)\left(w^2 + \dfrac{1}{2}x + \dfrac{1}{4}\right)$

97. $125v^3 - 1 = (5v)^3 - (1)^3$
$= (5v - 1)(25v^2 + 5v + 1)$

98. $343a^3 + 8 = (7a)^3 + (2)^3$
$= (7a + 2)(49a^2 - 14a + 4)$

99. $(y + 1)^3 - x^3 = (y + 1)^3 - (x)^3$
$= \left[(y + 1) - x\right]\left[(y + 1)^2 + x(y + 1) + x^2\right]$
$= (y - x + 1)(y^2 + 2y + 1 + xy + x + x^2)$
$= (-x + y + 1)(x^2 + y^2 + xy + x + 2y + 1)$

100. $(2x - z)^3 + 125y^3 = (2x - z)^3 + (5y)^3$
$= \left[(2x - z) + 5y\right]\left[(2x - z)^2 - 5y(2x - z) + 25y^2\right]$
$= (2x + 5y - z)(4x^2 - 4xz + z^2 - 10xy + 5yz + 25y^2)$
$= (2x + 5y - z)(4x^2 + 25y^2 + z^2 - 10xy - 4xz + 5yz)$

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

102. $x^2 + 6x + 8 = (x + 4)(x + 2)$

103. $s^2 - 5s + 6 = (s - 3)(s - 2)$

104. $t^2 - t - 6 = t^2 + 2t - 3t - 6 = (t + 2)(t - 3)$

105. $20 - y - y^2 = (5 + y)(4 - y)$
or $-(y + 5)(y - 4)$

106. $24 + 5z - z^2 = 24 + 8z - 3z - z^2$
$= (8 - z)(3 + z)$

107. $3x^2 + 13x - 10 = (3x - 2)(x + 5)$

108. $2x^2 - x - 21 = (2x - 7)(x + 3)$

109. $5x^2 + 26x + 5 = (5x + 1)(x + 5)$

110. $8x^2 - 45x - 18 = (x - 6)(8x + 3)$

111. $-5u^2 - 13u + 6 = -(5u^2 + 13u - 6)$
$= -(5u - 2)(u + 3)$
or $(2 - 5u)(u + 3)$

112. $-6x^2 + 23x + 4 = -(6x^2 - 23x - 4)$
$= -(x - 4)(6x + 1)$
or $(4 - x)(6x + 1)$

113. $\frac{1}{8}x^2 - \frac{1}{96}x - \frac{1}{16} = \frac{1}{8}\left(x^2 - \frac{1}{12}x - \frac{1}{2}\right)$
$= \frac{1}{8}\left(x - \frac{3}{4}\right)\left(x + \frac{2}{3}\right)$
$= \frac{1}{96}(4x - 3)(3x + 2)$

114. $\frac{1}{81}x^2 + \frac{2}{9}x - 8 = \frac{1}{81}\left[x^2 + 18x - 648\right]$
$= \frac{1}{81}(x - 18)(x + 36)$
or $\left(\frac{1}{9}x - 2\right)\left(\frac{1}{9}x + 4\right)$

115. $x^3 - x^2 + 2x - 2 = x^2(x - 1) + 2(x - 1)$
$= (x - 1)(x^2 + 2)$

116. $x^3 + 5x^2 - 5x - 25 = x^2(x + 5) - 5(x + 5)$
$= (x + 5)(x^2 - 5)$

117. $x^3 - 5x^2 + x - 5 = x^2(x - 5) + (x - 5)$
$= (x^2 + 1)(x - 5)$

118. $x^3 - x^2 + 3x - 3 = x^2(x - 1) + 3(x - 1)$
$= (x^2 + 3)(x - 1)$

119. $x^2 + x - 20 = x^2 + 5x - 4x - 20$
$= x(x + 5) - 4(x + 5)$
$= (x + 5)(x - 4)$

120. $b^2 - 11b + 18 = b^2 - 9b - 2b + 18$
$= b(b - 9) - 2(b - 9)$
$= (b - 9)(b - 2)$

121. $6x^2 + x - 2$

$a = 6,\ c = -2,\ ac = -12 = 4(-3)$, and

$4 - 3 = 1 = b.$

Thus, $6x^2 + x - 2 = 6x^2 + 4x - 3x - 2$

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

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

122. $a = 3,\ c = 8,\ ac = 24 = 6(4)$, and

$6 + 4 = 10 = b.$

Thus, $3x^2 + 10x + 8 = 3x^2 + 4x + 6x + 8$

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

$= (x + 2)(3x + 4).$

123. $10x^2 - 40 = 10(x^2 - 4) = 10(x + 2)(x - 2)$

124. $7z^2 - 63 = 7(z^2 - 9) = 7(z + 3)(z - 3)$

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

126. $x^3 - 9x^2 = x^2(x - 9)$

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

128. $9x^2 - 6x + 1 = (3x - 1)^2$

129. $1 - 4x + 4x^2 = (1 - 2x)^2 = (2x - 1)^2$

130. $16 - 6x - x^2 = -(x^2 + 6x - 16)$

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

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

131. $2x^2 + 6x - 2x^3 = -2x^3 + 2x^2 + 6x$

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

132. $7y^2 + 15y - 2y^3 = -y(2y^2 - 7y - 15)$

$= -y(2y + 3)(y - 5)$

133. $9x^2 + 10x + 1 = (9x + 1)(x + 1)$

134. $13x + 6 + 5x^2 = 5x^2 + 13x + 6$

$= 5x^2 + 10x + 3x + 6$

$= (5x + 3)(x + 2)$

135. $3x^3 + x^2 + 15x + 5 = x^2(3x + 1) + 5(3x + 1)$

$= (3x + 1)(x^2 + 5)$

136. $5 - x + 5x^2 - x^3 = 1(5 - x) + x^2(5 - x)$

$= (5 - x)(1 + x^2)$

137. $3u - 2u^2 + 6 - u^3 = -u^3 - 2u^2 + 3u + 6$

$= -u^2(u + 2) + 3(u + 2)$

$= (3 - u^2)(u + 2)$

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

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

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

139. $2x^3 + x^2 - 8x - 4 = x^2(2x + 1) - 4(2x + 1)$

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

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

140. $3x^3 + x^2 - 27x - 9 = x^2(3x + 1) - 9(3x + 1)$

$= (x^2 - 9)(3x + 1)$

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

141. $(x^2 + 1)^2 - 4x^2 = [(x^2 + 1) + 2x][(x^2 + 1) - 2x]$

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

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

142. $(x^2 + 8)^2 - 36x^2 = (x^2 + 8)^2 - (6x)^2$

$= [(x^2 + 8) - 6x][(x^2 + 8) + 6x]$

$= (x^2 - 6x + 8)(x^2 + 6x + 8)$

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

143. $3t^3 + 24 = 3(t^3 + 8) = 3(t + 2)(t^2 - 2t + 4)$

144. $4x^3 - 32 = 4(x^3 - 8) = 4(x - 2)(x^2 + 2x + 4)$

145. $4x(2x - 1) + 2(2x - 1)^2 = 2(2x - 1)(2x + (2x - 1))$

$= 2(2x - 1)(4x - 1)$

146. $5(3 - 4x)^2 - 8(3 - 4x)(5x - 1)$

$= (3 - 4x)[5(3 - 4x) - 8(5x - 1)]$

$= (3 - 4x)[15 - 20x - 40x + 8]$

$= (3 - 4x)(23 - 60x)$

147. $2(x+1)(x-3)^2 - 3(x+1)^2(x-3)$

$= (x+1)(x-3)\left[2(x-3) - 3(x+1)\right]$

$= (x+1)(x-3)\left[2x-6-3x-3\right]$

$= (x+1)(x-3)(-x-9)$

$= -(x+1)(x-3)(x+9)$

148. $7(3x+2)^2(1-x)^2 + (3x+2)(1-x)^3$

$= (3x+2)(1-x)^2\left[7(3x+2) + (1-x)\right]$

$= (3x+2)(1-x)^2(21x+14+1-x)$

$= (3x+2)(1-x)^2(20x+15)$

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

149. (a) $1000(1+r^2) = 1000(1+2r+r^2)$

$= 1000r^2 + 2000r + 1000$

(b)

r	1%	$1\frac{1}{2}\%$	2%	$2\frac{1}{2}\%$	3%
$1000(1+r)^2$	1020.10	1030.23	1040.40	1050.63	1060.90

(c) The amount increases as r increases.

150. $V = l \cdot w \cdot h = (26-2x)(18-2x)(x)$

$= 2(13-x)(2)(9-x)(x)$

$= 4x(-1)(x-13)(-1)(x-9)$

$= 4x(x-13)(x-9)$

When $x = 1$: $V = 4(1)(-12)(-8) = 384$ cubic inches.

When $x = 2$: $V = 4(2)(-11)(-7) = 616$ cubic inches.

When $x = 3$: $V = 4(3)(-10)(-6) = 720$ cubic inches.

151. (a) $T = R + B = 1.1x + (0.0475x^2 - 0.001x + 0.23)$

$= 0.0475x^2 + 1.099x + 0.23$

(b)

x mi/hr	30	40	55
T feet	75.95	120.19	204.36

(c) As the speed x increases, the total stopping distance increases.

152. (a) Estimates will vary. Actual safe loads for $x = 12$:

$S_6 = \left(0.06(12)^2 - 2.42(12) + 38.71\right)^2$

$= 335.2561$(using a calculator)

$S_8 = \left(0.08(12)^2 - 3.30(12) + 51.93\right)^2$

$= 568.8225$(using a calculator)

Difference in safe loads $= 568.8225 - 335.2561$

$= 233.6$ pounds

(b) The difference in safe loads decreases in magnitude as the span increases.

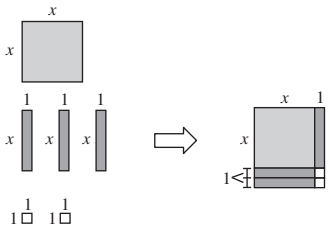
153. $a^2 - b^2 = (a+b)(a-b)$

Matches model (a).

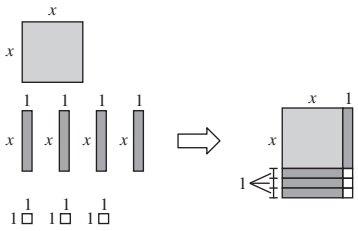
154. $ab + a + b + 1 = (a+1)(b+1)$

Matches model (b).

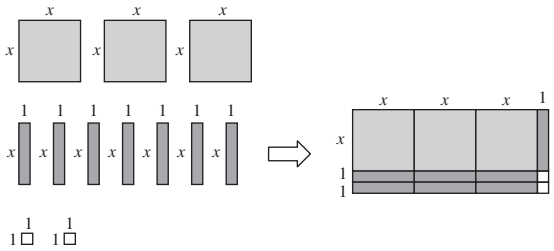
155. $x^2 + 3x + 2 = (x+2)(x+1)$



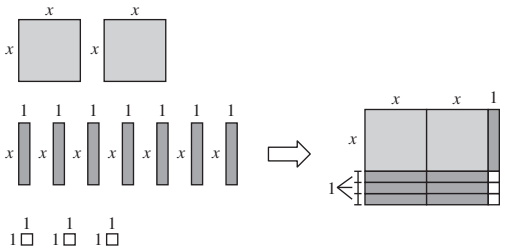
156. $x^2 + 4x + 3 = (x+3)(x+1)$



157. $3x^2 + 7x + 2 = (3x+1)(x+2)$



158. $2x^2+7x+3=(2x+1)(x+3)$



159. $A=\pi(r+2)^2-\pi r^2=\pi\left[(r+2)^2-r^2\right]$

$=\pi\left[r^2+4r+4-r^2\right]=\pi(4r+4)$

$=4\pi(r+1)$

160. Area $=\frac{1}{2}(x+3)\left(\frac{5}{4}\right)(x+3)-\frac{1}{2}(5)(4)$

$=\frac{5}{8}\left(x^2+6x+9\right)-10$

$=\frac{5}{8}\left(x^2+6x+9-\frac{80}{5}\right)$

$=\frac{5}{8}\left(x^2+6x+9-16\right)$

$=\frac{5}{8}\left(x^2+6x-7\right)$

$=\frac{5}{8}(x+7)(x-1)$

161. $x^4(4)(2x+1)^3(2x)+(2x+1)^4\left(4x^3\right)$

$=4x^3(2x+1)^3\left[2x^2+(2x+1)\right]$

$=4x^3(2x+1)^3\left(2x^2+2x+1\right)$

162. $x^3(3)\left(x^2+1\right)^2(2x)+\left(x^2+1\right)^3\left(3x^2\right)$

$=3x^2\left(x^2+1\right)^2\left[2x^2+\left(x^2+1\right)\right]$

$=3x^2\left(x^2+1\right)^2\left(3x^2+1\right)$

163. $(2x-5)^4(3)(5x-4)^2(5)+(5x-4)^3(4)(2x-5)^3(2)$

$=(2x-5)^3(5x-4)^2\left[15(2x-5)+8(5x-4)\right]$

$=(2x-5)^3(5x-4)^2\left[30x-75+40x-32\right]$

$=(2x-5)^3(5x-4)^2(70x-107)$

164. $\left(x^2-5\right)^3(2)(4x+3)(4)+(4x+3)^2(3)\left(x^2-5\right)^2\left(x^2\right)$

$=\left(x^2-5\right)^2(4x+3)\left[8\left(x^2-5\right)+3x^2(4x+3)\right]$

$=\left(x^2-5\right)^2(4x+3)\left(12x^3+17x^2-40\right)$

165. $\dfrac{4(2x+3)^2-(4x-1)(2)(2x+3)(2)}{(2x+3)^4}=\dfrac{4(2x+3)\left[(2x+3)-(4x-1)\right]}{(2x+3)^4}$

$=\dfrac{4(2x+3)[-2x+4]}{(2x+3)^4}$

$=\dfrac{-8(2x+3)(x-2)}{(2x+3)^4}$

$=\dfrac{-8(x-2)}{(2x+3)^3}$

166. $\dfrac{3(5x-1)^3-(3x+1)(3)(5x-1)^2(5)}{(5x-1)^6}=\dfrac{3(5x-1)^2\left[(5x-1)-(5)(3x+1)\right]}{(5x-1)^6}$

$=\dfrac{3(5x-1)^2[5x-1-15x-5]}{(5x-1)^6}$

$=\dfrac{3(5x-1)^2(-10x-6)}{(5x-1)^6}$

$=\dfrac{-6(5x-1)^2(5x+3)}{(5x-1)^6}$

$=-\dfrac{6(5x+3)}{(5x-1)^4}$

167. For $x^2 + bx - 15 = (x + m)(x + n)$ to be factorable, b must equal $m + n$ where $mn = -15$.

Factors of -15	Sum of factors
$(15)(-1)$	$15 + (-1) = 14$
$(-15)(1)$	$-15 + 1 = -14$
$(3)(-5)$	$3 + (-5) = -2$
$(-3)(5)$	$-3 + 5 = 2$

The possible b-value are $14,\ -14,\ -2,$ or 2.

168. For $x^2 + bx - 12$ to be factorable, b must equal $m + n$ where $mn = -12$.

Factors of -12	Sum of factors
$(1)(-12)$	$1 - 12 = -11$
$(-1)(12)$	$-1 + 12 = 11$
$(2)(-6)$	$2 - 6 = -4$
$(-2)(6)$	$-2 + 6 = 4$
$(3)(-4)$	$3 - 4 = -1$
$(-3)(4)$	$-3 + 4 = 1$

The possible b-values are
$11,\ -11,\ 4,\ -4,\ 1$ or -1.

169. For $x^2 + bx + 50 = (x + m)(x + n)$ to be factorable, b must equal $m + n$ where $mn = 50$.

Factors of 50	Sum of factors
$(50)(1)$	51
$(-50)(-1)$	-51
$(25)(2)$	27
$(-25)(-2)$	-27
$(10)(5)$	15
$(-10)(-5)$	-15

The possible b-values are
$51,\ -51,\ 27,\ -27,\ 15,$ or -15.

170. For $x^2 + bx + 24$ to be factorable, b must be equal to $m + n$ where $mn = 24$.

Factors of 24	Sum of factors
$(24)(1)$	25
$(-24)(-1)$	-25
$(12)(2)$	14
$(-12)(-2)$	-14
$(8)(3)$	11
$(-8)(-3)$	-11
$(6)(4)$	10
$(-6)(-4)$	-10

The possible b-values are
$25,\ -25,\ 14,\ -14,\ 11,\ -11,\ 10$ or -10.

171. For $x^2 + x + c$ to be factorable, the factors of c must add up to 1.

Possible c-values	c	Factors of c that add up to 1
-2	-2	$(2)(-1) = -2$ and $2 + (-1) = 1$
-6	-6	$(3)(-2) = -6$ and $3 + (-2) = 1$
-20	-20	$(5)(-4) = -20$ and $5 + (-4) = 1$

These are a few possible c-values. There are many correct answers.

If $c = -2$: $x^2 + x - 2 = (x + 2)(x - 1)$

If $c = -6$: $x^2 + x - 6 = (x + 3)(x - 2)$

If $c = -20$: $x^2 + x - 20 = (x + 5)(x - 4)$

172. For $x^2 - 9x + c$ to be factorable, the factors of c must add up to -9.

Possible c-values	c	Factors of c that add up to -9
8	8	$(-1)(-8) = 8$ and $-1 + (-8) = -9$
14	14	$(-2)(-7) = 14$ and $-2 + (-7) = -9$
18	18	$(-3)(-6) = 18$ and $-3 + (-6) = -9$

These are a few possible c-values. There are many correct answers.

If $c = 8$: $x^2 - 9x + 8 = (x - 1)(x - 8)$

If $c = 14$: $x^2 - 9x + 14 = (x - 2)(x - 7)$

If $c = 18$: $x^2 - 9x + 18 = (x - 3)(x - 6)$

173. For $2x^2 + 5x + c$ to be factorable, the factors of $2c$ must add up to 5.

Possible c-values	2c	Factors of 2c that add up to 5
2	4	$(1)(4) = 4$ and $1 + 4 = 5$
3	6	$(2)(3) = 6$ and $2 + 3 = 5$
–3	–6	$(6)(-1) = -6$ and $6 + (-1) = 5$
–7	–14	$(7)(-2) = -14$ and $7 + (-2) = 5$
–12	–24	$(8)(-3) = -24$ and $8 + (-3) = 5$

These are a few possible c-values. There are many correct answers.

If $c = 2$: $2x^2 + 5x + 2 = (2x + 1)(x + 2)$

If $c = 3$: $2x^2 + 5x + 3 = (2x + 3)(x + 1)$

If $c = -3$: $2x^2 + 5x - 3 = (2x - 1)(x + 3)$

If $c = -7$: $2x^2 + 5x - 7 = (2x + 7)(x - 1)$

If $c = -12$: $2x^2 + 5x - 12 = (2x - 3)(x + 4)$

174. For $3x^2 - 10x + c$ to be factorable, of $3c$ must add up to -10.

Possible c-values	$3c$	Factors of $3c$ that must add up to -10
3	9	$(-9)(-1) = 9$ and $-9 - 1 = -10$
7	21	$(-3)(-7) = 21$ and $-3 - 7 = -10$
8	24	$(-4)(-6) = 24$ and $-4 - 6 = -10$
–8	–24	$(2)(-12) = -24$ and $-12 + 2 = -10$

Other c-values are possible. The above values yield the following factorizations.

There are many correct answers.

If $c = 3$: $3x^2 - 10x + 3 = (3x - 1)(x - 3)$

If $c = 7$: $3x^2 - 10x + 7 = (3x - 7)(x - 1)$

If $c = 8$: $3x^2 - 10x + 8 = (3x - 4)(x - 2)$

If $c = -8$: $3x^2 - 10x - 8 = (3x + 2)(x - 4)$

175. $V = \pi R^2 h - \pi r^2 h$

(a) $V = \pi h\left[R^2 - r^2\right] = \pi h(R - r)(R + r)$

(b) The average radius is $\dfrac{R + r}{2}$. The thickness of the shell is $R - r$. Therefore,

$$V = \pi h(R + r)(R - r) = 2\pi\left(\frac{R + r}{2}\right)(R - r)h$$

$= 2\pi$ (average radius)(thickness)h.

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

177. False. The product of the two binomials is not always a second-degree polynomial. For instance, $(x^2 + 2)(x^2 - 3) = x^4 - x^2 - 6$ is a fourth-degree polynomial.

178. False. The product of the two binomials is not always a trinomial. For example, $(x + 2)(x - 2) = x^2 - 4$.

179. False. For example, $(x^2 - 3x + 1) + (-x^2 + x - 2) = -2x - 1$, which is a first-degree polynomial.

180. False. The sum of a third-degree polynomial and a fourth-degree polynomial will always be a fourth-degree polynomial.

181. False. $(3x - 6)(x + 1) = 3(x - 2)(x + 1)$

182. (a) The box could have been created by cutting squares of length x from the corners of the piece of cardboard. The original dimensions of the cardboard are 52 inches × 42 inches.

(b) The degree is 3 because the volume is length × width × height, and each dimension contains an x.

(c) $x(52 - 2x)(42 - 2x) = 4x(26 - x)(21 - x)$

The possible values of x are $0 < x < 21$.

183. If two polynomials have degree m and n, then their product is degree $m + n$.

184. $(x + y)^2 \neq x^2 + y^2$ because you cannot just distribute the squares. You have to use the FOIL Method.

$(x + y)^2 = x^2 + 2xy + y^2 \neq x^2 + y^2$

185. To cube a binomial difference, cube the first term. Next, subtract 3 times the square of the first term times the second term. Next, add 3 times the first term times the square of the second term. Finally, subtract the cube of the second term.

$(x - y)^3 = x^3 - 3x^2y + 3xy^2 - y^3$

186. A polynomial is in factored form when each of its factors is prime (it cannot be factored any further using integer coefficients).

187. $9x^2 - 9x - 54 = 9(x^2 - x - 6) = 9(x + 2)(x - 3)$

The error in the problem in the book was that 3 was factored out of the first binomial but not out of the second binomial.

$(3x + 6)(3x - 9) = 3(x + 2)(3)(x - 3) = 9(x + 2)(x - 3)$

188. Answers will vary. Sample answer: $x^2 - 3$

189. $x^{2n} - y^{2n} = (x^n + y^n)(x^n - y^n)$

190. $x^{3n} + y^{3n} = (x^n + y^n)(x^{2n} - x^n y^n + y^{2n})$

Section P.4 Rational Expressions

1. domain

2. rational expression

3. complex fractions

4. lesser

5. A rational expression is in simplest form when its numerator and denominator have no common factors aside from ± 1.

6. Values that make the denominator equal to zero are excluded from the domain of a rational expression.

7. The domain of the polynomial $x^2 + 7x - 3$ is the set of all real numbers.

8. The domain of the polynomial $6x^2 - x - 10$ is the set of all real numbers.

9. The domain of the polynomial $5x^2 + 1, x > 0$, is the set of all positive real numbers.

10. The domain of the polynomial $9x - 4, x \leq 0$, is the set of all negative real numbers.

11. The domain of the expression $\dfrac{x}{x+2}$ is the set of all real numbers except $x = -2$, which would result in division by zero, which is undefined.

12. The domain of the expression $\dfrac{1-x}{4-x}$ is the set of all real numbers except $x = 4$, which would result in division by zero, which is undefined.

13. The domain of the expression $\dfrac{x^2 + 3x}{x^2 + 14x + 49} = \dfrac{x(x+3)}{(x+7)^2}$ is the set of all real numbers except $x = -7$, which would result in division by zero, which is undefined.

14. The domain of the expression $\dfrac{x^2 + 2x - 8}{x^2 - 4} = \dfrac{(x+4)(x-2)}{(x+2)(x-2)} = \dfrac{x+4}{x+2}, x \neq 2$, is the set of all real numbers except $x = \pm 2$, which would result in division by zero, which is undefined.

15. The domain of the expression $\dfrac{x^2 - 2x - 3}{9x^2 - 1} = \dfrac{(x-3)(x+1)}{(3x+1)(3x-1)}$ is the set of all real numbers except $x = \pm\dfrac{1}{3}$, which would result in division by zero, which is undefined.

16. The domain of the expression $\dfrac{x^2 + 6x + 9}{x^2 - 10x + 25} = \dfrac{(x+3)^2}{(x-5)^2}$ is the set of all real numbers except $x = 5$, which would result in division by zero, which is undefined.

17. The domain of the radical expression $\sqrt{x+10}$ is the set of all real numbers greater than or equal to -10, because the square root of a negative number is not a real number.

18. The domain of the radical expression $\sqrt{x-7}$ is the set of all real numbers greater than or equal to 7 because the square root of a negative number is not a real number.

19. Because $12 - 3x \geq 0 \Rightarrow x \leq 4$, the domain of the radical expression $\sqrt{12 - 3x}$ is the set of all real numbers less than or equal to 4.

20. Because $6 - 4x \geq 0 \Rightarrow x \leq \dfrac{3}{2}$, the domain of the radical expression $\sqrt{6 - 4x}$ is the set of all real numbers less than or equal to $\dfrac{3}{2}$.

21. Because $x + 1 > 0 \Rightarrow x > -1$, the domain of the radical expression $\dfrac{1}{\sqrt{x+1}}$ is the set of all real numbers greater than -1.

22. Because $x - 5 > 0 \Rightarrow x > 5$, the domain of the radical expression $\dfrac{1}{\sqrt{x-5}}$ is the set of all real numbers greater than 5.

23. $\dfrac{5}{2x}=\dfrac{5(3x)}{(2x)(3x)}=\dfrac{5(3x)}{6x^2},\ x\neq 0$

Missing factor: $3x$

24. $\dfrac{2}{3x^2}=\dfrac{2(x^2)}{(3x^2)(x^2)}=\dfrac{2(x^2)}{3x^4},\ x\neq 0$

Missing factor: x^2

25. $\dfrac{3}{4}=\dfrac{3(x+1)}{4(x+1)},\ x\neq 1$

Missing factor: $(x+1)$

26. $\dfrac{2}{5}=\dfrac{2(x-3)}{5(x-3)},\ x\neq 3$

Missing factor: $x-3$

27. $\dfrac{x-1}{4(x+2)}=\dfrac{(x-1)(x+2)}{4(x+2)(x+2)}$

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

Missing factor: $x+2$

28. $\dfrac{x+3}{2(x-1)}=\dfrac{(x+3)(x-1)}{2(x-1)(x-1)}$

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

Missing factor: $x-1$

29. $\dfrac{15x^2}{10x}=\dfrac{5x(3x)}{5x(2)}=\dfrac{3x}{2},\ x\neq 0$

30. $\dfrac{18y^2}{60y^5}=\dfrac{6y^2(3)}{6y^2(10y^3)}=\dfrac{3}{10y^3},\ y\neq 0$

31. $\dfrac{3xy}{x^2y+x^2}=\dfrac{3xy}{x^2(y+1)}=\dfrac{3y}{x(y+1)}$

32. $\dfrac{2x^2y}{xy-y}=\dfrac{y(2x^2)}{y(x-1)}=\dfrac{2x^2}{x-1},\ y\neq 0$

33. $\dfrac{4y-8y^2}{10y-5}=\dfrac{4y(1-2y)}{5(2y-1)}$

$=\dfrac{-4y(2y-1)}{5(2y-1)}=-\dfrac{4y}{5},\ y\neq\dfrac{1}{2}$

34. $\dfrac{9x^2+9x}{2x+2}=\dfrac{9x(x+1)}{2(x+1)}=\dfrac{9x}{2},\ x\neq -1$

35. $\dfrac{x-5}{10-2x}=\dfrac{x-5}{-2(x-5)}=-\dfrac{1}{2},\ x\neq 5$

36. $\dfrac{12-4x}{x-3}=\dfrac{-4(x-3)}{x-3}=-4,\ x\neq 3$

37. $\dfrac{y^2-16}{y+4}=\dfrac{(y+4)(y-4)}{y+4}=y-4,\ y\neq -4$

38. $\dfrac{x^2-25}{5-x}=\dfrac{(x+5)(x-5)}{-1(x-5)}=-(x+5),\ x\neq 5$

39. $\dfrac{x^3+5x^2+6x}{x^2-4}=\dfrac{x(x+2)(x+3)}{(x+2)(x-2)}$

$=\dfrac{x(x+3)}{x-2},\ x\neq -2$

40. $\dfrac{x^2+8x-20}{x^2+11x+10}=\dfrac{(x+10)(x-2)}{(x+10)(x+1)}$

$=\dfrac{x-2}{x+1},\ x\neq -10$

41. $\dfrac{y^2-7y+12}{y^2+3y-18}=\dfrac{(y-3)(y-4)}{(y+6)(y-3)}=\dfrac{y-4}{y+6},\ y\neq 3$

42. $\dfrac{-10-x}{x^2+11x+10}=\dfrac{-(x+10)}{(x+10)(x+1)}$

$=-\dfrac{1}{x+1},\ x\neq -10$

43. $\dfrac{2-x+2x^2-x^3}{x-2}=\dfrac{(2-x)+x^2(2-x)}{-(2-x)}$

$=\dfrac{(2-x)(1+x^2)}{-(2-x)}$

$=-(1+x^2),\ x\neq 2$

44. $\dfrac{x^2-9}{x^3+x^2-9x-9}=\dfrac{x^2-9}{(x^2-9)(x+1)}$

$=\dfrac{1}{x+1},\ x\neq\pm 3$

45. $\dfrac{z^3-8}{z^2+2z+4}=\dfrac{(z-2)(z^2+2z+4)}{z^2+2z+4}=z-2$

46. $\dfrac{y^3-2y^2-3y}{y^3+1}=\dfrac{y(y-3)(y+1)}{(y+1)(y^2-y+1)}$

$=\dfrac{y(y-3)}{y^2-y+1},\ y\neq -1$

47.

x	-4	-3	-2	-1	0	1	2
$\dfrac{x^2+2x-3}{x-1}$	-1	0	1	2	3	Undef.	5
$x+3$	-1	0	1	2	3	4	5

The expressions are equivalent except at $x = 1$. In fact, $\dfrac{x^2+2x-3}{x-1} = \dfrac{(x+3)(x-1)}{x-1} = x+3, x \neq 1.$

48.

x	0	1	2	3	4	5	6
$\dfrac{x-3}{x^2-x-6}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	Undef.	$\frac{1}{6}$	$\frac{1}{7}$	$\frac{1}{8}$
$\dfrac{1}{x+2}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{6}$	$\frac{1}{7}$	$\frac{1}{8}$

The expressions are equivalent except at $x=3$.

In fact, $\dfrac{x-3}{x^2-x-6}=\dfrac{x-3}{(x-3)(x+2)}=\dfrac{1}{x+2}, x\neq 3.$

49. $\dfrac{5}{x-1}\cdot\dfrac{x-1}{25(x-2)}=\dfrac{1}{5(x-2)}, x\neq 1$

50. $\dfrac{x+13}{x^3(3-x)}\cdot\dfrac{x(x-3)}{5}=\dfrac{x+13}{x^3(x-3)(-1)}\cdot\dfrac{x(x-3)}{5}$

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

51. $\dfrac{r}{1-r}\div\dfrac{r^2}{r^2-1} = -\dfrac{r}{r-1}\cdot\dfrac{r^2-1}{r^2}$

$= -\dfrac{r}{r-1}\cdot\dfrac{(r+1)(r-1)}{r^2}$

$= -\dfrac{r+1}{r}, r \neq -1, 1$

52. $\dfrac{4y-16}{5y+15}\div\dfrac{4-y}{2y+6}=\dfrac{4(y-4)}{5(y+3)}\cdot\dfrac{2(y+3)}{-(y-4)}$

$=\dfrac{8}{-5}=-\dfrac{8}{5}, y\neq -3, 4$

53. $\dfrac{t^2-t-6}{t^2+6t+9}\cdot\dfrac{t+3}{t^2-4}=\dfrac{(t-3)(t+2)(t+3)}{(t+3)^2(t+2)(t-2)}$

$=\dfrac{t-3}{(t+3)(t-2)}, t\neq -2$

54. $\dfrac{y^3-8}{2y^3}\cdot\dfrac{4y}{y^2-5y+6}=\dfrac{(y-2)(y^2+2y+4)}{2y^3}\cdot\dfrac{4y}{(y-2)(y-3)}$

$=\dfrac{2(y^2+2y+4)}{y^2(y-3)}, y\neq 2$

55. $\dfrac{3(x+y)}{4}\div\dfrac{x+y}{2}=\dfrac{3(x+y)}{4}\cdot\dfrac{2}{x+y}=\dfrac{3}{2}, x\neq -y$

56. $\dfrac{2x-y}{y-1}\div\dfrac{3y-6x}{y^2-6y+5} = \dfrac{2x-y}{y-1}\cdot\dfrac{y^2-6y+5}{-6x+3y}$

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

$= -\dfrac{y-5}{3}, y \neq 1, 5, 2x$

57. $\dfrac{\pi r^2}{(2r)^2}=\dfrac{\pi r^2}{4r^2}=\dfrac{\pi}{4}$

58. Area of shaded portion: $\left(\dfrac{x+5}{2}\right)^2=\dfrac{(x+5)^2}{4}$

Area of total figure: $(2x+3)(x+5)$

Ratio: $\dfrac{(x+5)^2/4}{(2x+3)(x+5)}=\dfrac{(x+5)/4}{(2x+3)}$

$=\dfrac{x+5}{4(2x+3)}, x\neq -5$

59. $\dfrac{5}{x-1}+\dfrac{x}{x-1}=\dfrac{5+x}{x-1}=\dfrac{x+5}{x-1}$

60. $\dfrac{2x-1}{x+3}-\dfrac{1-x}{x+3}=\dfrac{2x-1-1+x}{x+3}=\dfrac{3x-2}{x+3}$

61. $\dfrac{6}{2x+1}-\dfrac{x}{x+3}=\dfrac{6(x+3)-x(2x+1)}{(2x+1)(x+3)}$

$=\dfrac{6x+18-2x^2-x}{(2x+1)(x+3)}$

$=\dfrac{-2x^2+5x+18}{(2x+1)(x+3)}$

$=-\dfrac{2x^2-5x-18}{(2x+1)(x+3)}$

62. $\dfrac{3}{x-1}+\dfrac{5x}{3x+4}=\dfrac{3(3x+4)+5x(x-1)}{(x-1)(3x+4)}$

$=\dfrac{5x^2+4x+12}{(x-1)(3x+4)}$

63. $\dfrac{3}{x-2}+\dfrac{5}{2-x}=\dfrac{3}{x-2}-\dfrac{5}{x-2}=-\dfrac{2}{x-2}$

64. $\dfrac{2x}{x-5}-\dfrac{5}{5-x}=\dfrac{2x}{x-5}-\dfrac{5(-1)}{(-1)(5-x)}$

$=\dfrac{2x}{x-5}-\dfrac{-5}{x-5}=\dfrac{2x+5}{x-5}$

65. $\dfrac{1}{x^2-x-2}-\dfrac{x}{x^2-5x+6}=\dfrac{1}{(x-2)(x+1)}-\dfrac{x}{(x-2)(x-3)}$

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

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

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

66. $\dfrac{2}{x^2-x-2}+\dfrac{10}{x^2+2x-8}=\dfrac{2}{(x-2)(x+1)}+\dfrac{10}{(x+4)(x-2)}$

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

$+\dfrac{10(x+1)}{(x-2)(x+1)(x+4)}$

$=\dfrac{2x+8+10x+10}{(x-2)(x+1)(x+4)}$

$=\dfrac{12x+18}{(x-2)(x+1)(x+4)}$

$=\dfrac{6(2x+3)}{(x-2)(x+1)(x+4)}$

67. $\dfrac{2}{x+1}+\dfrac{2}{x-1}+\dfrac{1}{x^2-1}=\dfrac{2}{x+1}+\dfrac{2}{x-1}+\dfrac{1}{(x+1)(x-1)}$

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

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

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

68. $-\dfrac{1}{x}+\dfrac{2}{x^2+1}-\dfrac{1}{x^3+x}=\dfrac{-(x^2+1)}{x(x^2+1)}+\dfrac{2x}{x(x^2+1)}-\dfrac{1}{x(x^2+1)}$

$=\dfrac{-x^2-1+2x-1}{x(x^2+1)}$

$=-\dfrac{x^2-2x+2}{x(x^2+1)}$

69. $\dfrac{1}{x^2+x}-\dfrac{6}{x^2}+\dfrac{5}{x+1}=\dfrac{1}{x(x+1)}-\dfrac{6}{x^2}+\dfrac{5}{x+1}$

$=\dfrac{x-6(x+1)+5x^2}{x^2(x+1)}$

$=\dfrac{x-6x-6+5x^2}{x^2(x+1)}$

$=\dfrac{5x^2-5x-6}{x^2(x+1)}$

70. $\dfrac{3}{x-3}-\dfrac{x}{x^2-9}-\dfrac{2}{x}=\dfrac{3}{x-3}-\dfrac{x}{(x-3)(x+3)}-\dfrac{2}{x}$

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

$=\dfrac{3x^2+9x-x^2-2x^2+18}{x(x-3)(x+3)}$

$=\dfrac{9x+18}{x(x-3)(x+3)}$

71. $$\frac{\left(\frac{x}{2}-1\right)}{(x-2)}=\frac{\left(\frac{x}{2}-\frac{2}{2}\right)}{\left(\frac{x-2}{1}\right)}$$
$$=\frac{x-2}{2}\cdot\frac{1}{x-2}=\frac{1}{2},\ x\neq 2$$

72. $$\frac{(x-4)}{\left(\frac{x}{4}-\frac{4}{x}\right)}=\frac{\left(\frac{x-4}{1}\right)}{\left(\frac{x^2}{4x}-\frac{16}{4x}\right)}=\frac{\left(\frac{x-4}{1}\right)}{\left(\frac{x^2-16}{4x}\right)}$$
$$=\frac{x-4}{1}\cdot\frac{4x}{x^2-16}$$
$$=\frac{x-4}{1}\cdot\frac{4x}{(x+4)(x-4)}$$
$$=\frac{4x}{x+4},\ x\neq 0,\ 4$$

73. $$\frac{\left[\frac{x^2}{(x+1)^2}\right]}{\left[\frac{x}{(x+1)^3}\right]}=\frac{x^2}{(x+1)^2}\cdot\frac{(x+1)^3}{x}$$
$$=\frac{x(x+1)}{1}$$
$$=x^2+x,\ x\neq 0,\ -1$$

74. $$\frac{\left(\frac{x^2-1}{x}\right)}{\left[\frac{(x-1)^2}{x}\right]}=\frac{x^2-1}{x}\cdot\frac{x}{(x-1)^2}$$
$$=\frac{(x+1)(x-1)}{(x-1)^2}$$
$$=\frac{x+1}{x-1},\ x\neq 0$$

75. $$\frac{\left[\frac{1}{(x+h)^2}-\frac{1}{x^2}\right]}{h}=\frac{\left[\frac{1}{(x+h)^2}-\frac{1}{x^2}\right]}{h}\cdot\frac{x^2(x+h)^2}{x^2(x+h)^2}$$
$$=\frac{x^2-(x+h)^2}{hx^2(x+h)^2}$$
$$=\frac{x^2-\left(x^2+2xh+h^2\right)}{hx^2(x+h)^2}$$
$$=\frac{-h(2x+h)}{hx^2(x+h)^2}$$
$$=-\frac{2x+h}{x^2(x+h)^2},\ h\neq 0$$

76. $$\frac{\left(\frac{x+h}{x+h+1}-\frac{x}{x+1}\right)}{h}$$
$$=\frac{\left(\frac{(x+h)(x+1)}{(x+h+1)(x+1)}-\frac{x(x+h+1)}{(x+h+1)(x+1)}\right)}{\frac{h}{1}}$$
$$=\left(\frac{(x+h)(x+1)}{(x+h+1)(x+1)}-\frac{x(x+h+1)}{(x+h+1)(x+1)}\right)\cdot\frac{1}{h}$$
$$=\left(\frac{x^2+x+hx+h-x^2-xh-x}{(x+h+1)(x+1)}\right)\cdot\frac{1}{h}$$
$$=\frac{h}{(x+h+1)(x+1)}\cdot\frac{1}{h}=\frac{1}{(x+h+1)(x+1)},\ h\neq 0$$

77. $$\frac{\left(\sqrt{x}-\frac{1}{2\sqrt{x}}\right)}{\sqrt{x}}=\frac{\left(\sqrt{x}-\frac{1}{2\sqrt{x}}\right)}{\sqrt{x}}\cdot\frac{2\sqrt{x}}{2\sqrt{x}}$$
$$=\frac{2x-1}{2x},\ x>0$$

78. $$\frac{\left(\frac{t^2}{\sqrt{t^2-1}}-\sqrt{t^2-1}\right)}{t^2}=\frac{\left(\frac{t^2-\left(t^2-1\right)}{\sqrt{t^2-1}}\right)}{t^2}$$
$$=\frac{\frac{1}{\sqrt{t^2-1}}}{t^2}$$
$$=\frac{1}{\sqrt{t^2-1}}\cdot\frac{1}{t^2}$$
$$=\frac{1}{t^2\sqrt{t^2-1}}$$

79. $$x^5-2x^{-2}=x^{-2}\left(x^7-2\right)=\frac{x^7-2}{x^2}$$

80. $$x^5-5x^{-3}=x^{-3}\left(x^8-5\right)=\frac{x^8-5}{x^3}$$

81. $$x^2\left(x^2+1\right)^{-5}-\left(x^2+1\right)^{-4}=\left(x^2+1\right)^{-5}\left[x^2-\left(x^2+1\right)\right]$$
$$=-\frac{1}{\left(x^2+1\right)^5}$$

82. $$2x(x-5)^{-3}-4x^2(x-5)^{-4}=2x(x-5)^{-4}(x-5-2x)$$
$$=\frac{2x(-x-5)}{(x-5)^4}=\frac{-2x(x+5)}{(x-5)^4}$$

83. $$2x^2(x-1)^{1/2}-5(x-1)^{-1/2}=(x-1)^{-1/2}\left(2x^2(x-1)-5\right)$$
$$=\frac{2x^3-2x^2-5}{(x-1)^{1/2}}$$

84. $4x^3(2x-1)^{3/2} - 2x(2x-1)^{-1/2} = 2x(2x-1)^{-1/2}\left(2x^2(2x-1)^2 - 1\right)$

$= 2x(2x-1)^{-1/2}\left(2x^2(4x^2-4x+1)-1\right)$

$= 2x(2x-1)^{-1/2}\left(8x^4-8x^3+2x^2-1\right)$

$= \dfrac{2x\left(8x^4-8x^3+2x^2-1\right)}{(2x-1)^{1/2}}$

85. $\dfrac{2x^{3/2}-x^{-1/2}}{x^2} = \dfrac{x^{-1/2}\left(2x^2-1\right)}{x^2} = \dfrac{2x^2-1}{x^{5/2}}$

86. $\dfrac{x^2\left(x^{-1/2}\right) - 3x^{1/2}\left(x^2\right)}{x^4} = \dfrac{x^{3/2} - 3x^{5/2}}{x^4}$

$= \dfrac{x^{3/2}(1-3x)}{x^4}$

$= -\dfrac{3x-1}{x^{5/2}}$

87. $\dfrac{-x^2\left(x^2+1\right)^{-1/2} + 2x\left(x^2+1\right)^{-3/2}}{x^3} = \dfrac{x\left(x^2+1\right)^{-3/2}\left[-x\left(x^2+1\right)+2\right]}{x^3}$

$= \dfrac{\left(x^2+1\right)^{-3/2}\left[-x^3-x+2\right]}{x^2} = \dfrac{-x^3-x+2}{x^2\left(x^2+1\right)^{3/2}}$

$= -\dfrac{(x-1)\left(x^2+x+2\right)}{x^2\left(x^2+1\right)^{3/2}}$

88. $\dfrac{x^3\left(4x^{-1/2}\right) - 3x^2\left(\frac{8}{3}x^{-3/2}\right)}{x^6} = \dfrac{4x^{5/2}-8x^{1/2}}{x^6} = \dfrac{4x^{1/2}\left(x^2-2\right)}{x^6} = \dfrac{4\left(x^2-2\right)}{x^{11/2}}$

89. $\dfrac{\left(x^2+5\right)\left(\frac{1}{2}\right)(4x+3)^{-1/2}(4) - (4x+3)^{1/2}(2x)}{\left(x^2+5\right)^2} = \dfrac{2(4x+3)^{-1/2}\left[\left(x^2+5\right) - x(4x+3)\right]}{\left(x^2+5\right)^2}$

$= \dfrac{2\left(-3x^2-3x+5\right)}{\left(x^2+5\right)^2\sqrt{4x+3}}$

$= -\dfrac{2\left(3x^2+3x-5\right)}{\left(x^2+5\right)^2\sqrt{4x+3}}$

90. $\dfrac{(2x+1)^{1/2}3(x-5)^2 - (x-5)^3\left(\frac{1}{2}\right)(2x+1)^{-1/2}(2)}{2x+1} = \dfrac{(x-5)^2(2x+1)^{-1/2}\left[3(2x+1)-(x-5)\right]}{2x+1}$

$= \dfrac{(x-5)^2(6x+3-x+5)}{(2x+1)^{3/2}}$

$= \dfrac{(x-5)^2(5x+8)}{(2x+1)^{3/2}}$

91. $$\frac{\sqrt{x+4}-\sqrt{x}}{4} = \frac{\sqrt{x+4}-\sqrt{x}}{4}\cdot\frac{\sqrt{x+4}+\sqrt{x}}{\sqrt{x+4}+\sqrt{x}}$$
$$= \frac{(x+4)-(x)}{4\left(\sqrt{x+4}+\sqrt{x}\right)}$$
$$= \frac{4}{4\left(\sqrt{x+4}+\sqrt{x}\right)}$$
$$= \frac{1}{\sqrt{x+4}+\sqrt{x}}$$

92. $$\frac{\sqrt{z-3}-\sqrt{z}}{3} = \frac{\sqrt{z-3}-\sqrt{z}}{3}\cdot\frac{\sqrt{z-3}+\sqrt{z}}{\sqrt{z-3}+\sqrt{z}}$$
$$= \frac{(z-3)-z}{3\left(\sqrt{z-3}+\sqrt{z}\right)} = \frac{-3}{3\left(\sqrt{z-3}+\sqrt{z}\right)} = \frac{-1}{\sqrt{z-3}+\sqrt{z}}$$

93. $$\frac{\sqrt{x+2}-\sqrt{2}}{x} = \frac{\sqrt{x+2}-\sqrt{2}}{x}\cdot\frac{\sqrt{x+2}+\sqrt{2}}{\sqrt{x+2}+\sqrt{2}}$$
$$= \frac{(x+2)-2}{x\left(\sqrt{x+2}+\sqrt{2}\right)}$$
$$= \frac{x}{x\left(\sqrt{x+2}+\sqrt{2}\right)}$$
$$= \frac{1}{\sqrt{x+2}+\sqrt{2}},\ x \neq 0$$

94. $$\frac{\sqrt{x+5}-\sqrt{5}}{x} = \frac{\sqrt{x+5}-\sqrt{5}}{x}\cdot\frac{\sqrt{x+5}+\sqrt{5}}{\sqrt{x+5}+\sqrt{5}}$$
$$= \frac{(x+5)-5}{x\left(\sqrt{x+5}+\sqrt{5}\right)}$$
$$= \frac{x}{x\left(\sqrt{x+5}+\sqrt{5}\right)}$$
$$= \frac{1}{\sqrt{x+5}+\sqrt{5}},\ x \neq 0$$

95. $$\frac{\sqrt{1-x}-1}{x} = \frac{\sqrt{1-x}-1}{x}\cdot\frac{\sqrt{1-x}+1}{\sqrt{1-x}+1}$$
$$= \frac{(1-x)-(1)}{x\left(\sqrt{1-x}+1\right)}$$
$$= \frac{-x}{x\left(\sqrt{1-x}+1\right)}$$
$$= -\frac{1}{\sqrt{1-x}+1},\ x \neq 0$$

96. $$\frac{\sqrt{4+x}-2}{x} = \frac{\sqrt{4+x}-2}{x}\cdot\frac{\sqrt{4+x}+2}{\sqrt{4+x}+2}$$
$$= \frac{(4+x)-(4)}{x\left(\sqrt{4+x}+2\right)}$$
$$= \frac{x}{x\left(\sqrt{4+x}+2\right)}$$
$$= \frac{1}{\sqrt{4+x}+2},\ x \neq 0$$

97. $$\text{Probability} = \frac{\text{Area shaded rectangle}}{\text{Area large rectangle}} = \frac{x(x/2)}{x(2x+1)} = \frac{x/2}{2x+1}\cdot\frac{2}{2} = \frac{x}{2(2x+1)}$$

98. $$\text{Probability} = \frac{\text{Shaded area}}{\dfrac{\text{(area of trapezoid)}}{\text{Total area}}} = \frac{\frac{1}{2}\cdot\frac{4}{x}(x+2)(x+x+4)}{\frac{1}{2}(x+4)\left[(x+2)+\frac{4}{x}(x+2)\right]}$$

$$= \frac{\frac{4(x+2)(2x+4)}{x}}{(x+4)(x+2)\left(1+\frac{4}{x}\right)} = \frac{\frac{4\cdot 2(x+2)^2}{x}}{(x+4)(x+2)\left(1+\frac{4}{x}\right)}$$

$$= \frac{8(x+2)^2}{x}\cdot\frac{1}{(x+4)(x+2)\left(1+\frac{4}{x}\right)}$$

$$= \frac{8(x+2)^2}{(x+4)(x+2)(x+4)} = \frac{8(x+2)}{(x+4)^2}$$

In Exercises 99 and 100, use the formula

$$r = \frac{\left[\dfrac{24(NM-P)}{N}\right]}{\left(P+\dfrac{NM}{12}\right)}.$$

99. (a) $N = (4)(12) = 48$

$M = \$475$

$P = \$20{,}000$

$$r = \frac{\left[\dfrac{24\left((48)(475)-20{,}000\right)}{48}\right]}{\left(20{,}000+\dfrac{(48)(475)}{12}\right)}$$

$r \approx 0.0639 \Rightarrow 6.39\%$

(b) $$r = \frac{\left[\dfrac{24(NM-P)}{N}\right]}{\left(P+\dfrac{NM}{12}\right)} = \frac{\dfrac{24(NM-P)}{N}}{\dfrac{12P+NM}{12}}$$

$$= \frac{24(NM-P)}{N}\cdot\frac{12}{12P+NM} = \frac{288(NM-P)}{N(12P+NM)}$$

$$r = \frac{288(48\cdot 475-20{,}000)}{48(12\cdot 20{,}000+48\cdot 475)} \approx 0.0639 \Rightarrow 6.39\%$$

100. (a) $N = (5)(12) = 60$

$M = \$525$

$P = \$28{,}000$

$$r = \frac{\left[\dfrac{24\left((60)(525)-28{,}000\right)}{60}\right]}{\left(28{,}000+\dfrac{(60)(525)}{12}\right)}$$

$r \approx 0.0457 \Rightarrow 4.57\%$

(b) $$r = \frac{\left[\dfrac{24(NM-P)}{N}\right]}{\left(P+\dfrac{NM}{12}\right)} = \frac{\dfrac{24(NM-P)}{N}}{\dfrac{12P+NM}{12}}$$

$$= \frac{24(NM-P)}{N}\cdot\frac{12}{12P+NM} = \frac{288(NM-P)}{N(12P+NM)}$$

$$r = \frac{288(60\cdot 525-28{,}000)}{60(12\cdot 28{,}000+60\cdot 525)} \approx 0.0457 \Rightarrow 4.57\%$$

101. $$\text{Copy rate} = \frac{50 \text{ pages}}{1 \text{ minute}}$$

(a) The time required to copy one page $= \frac{1}{50}$ minute

(b) The time required to copy x pages $= x\left(\frac{1}{50}\right)$

$= \frac{x}{50}$ minutes

(c) The time required to copy

120 pages $= 120\left(\frac{1}{50}\right) = \frac{12}{5}$ minutes or 2.4 minutes