

Preface

This manual contains detailed solutions to all of the exercises of the text *College Algebra*, eleventh edition, by R. David Gustafson and Jeff Hughes.

Many of the exercises in the text may be solved using more than one method, but it is not feasible to list all possible solutions in this manual. Also, some of the exercises may have been solved in this manual using a method that differs slightly from that presented in the text. There are a few exercises in the text whose solutions may vary from person to person. Some of these solutions may not have been included in this manual. For the solution to an exercise like this, the notation "answers may vary" has been included.

If you are a student using this manual, please remember that only reading a solution does not teach you how to solve a problem. To repeat a commonly used phrase, mathematics is not a spectator sport. You **MUST** make an honest attempt to solve each exercise in the text without using this manual first. This manual should be viewed more or less as a last resort. Above all, **DO NOT** simply copy the solution from this manual onto your own paper. Doing so will not help you learn how to do the exercise, nor will it help you to do better on quizzes or tests.

I would like to thank Paul McCombs from Rock Valley College and Cynthia Ashton of Brooks/Cole Publishing Company for their help and support. This solutions manual was prepared using EXP 5.1.

This book is dedicated to John, who helps me to realize that mathematics cannot describe everything in life.

May your study of this material be successful and rewarding.

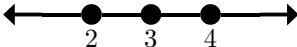

Michael G. Welden

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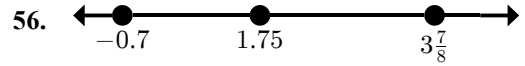
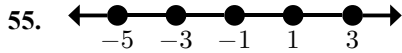
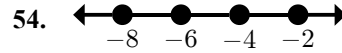
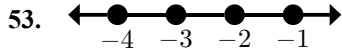
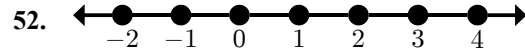
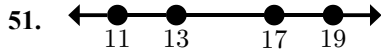
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SECTION 0.1

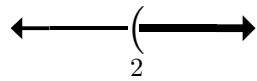
Exercises 0.1 (page 13)

- | | | | |
|--|--|---|--|
| 1. set | 2. subset | 3. union | 4. intersection |
| 5. decimal | 6. variable | 7. 2 | 8. even |
| 9. composite | 10. rational | 11. decimals | 12. \leq |
| 13. negative | 14. 0 | 15. $x + (y + z)$ | 16. yx |
| 17. $5m + 5 \cdot 2$ | 18. commutative,
multiplication | 19. interval | 20. no |
| 21. two | 22. half-open | 23. positive | 24. distance |
| 25. Every natural number is a whole number,
so $\mathbf{N} \subset \mathbf{W}$. TRUE | 26. Every rational number is a real number,
so $\mathbf{Q} \subset \mathbf{R}$. TRUE | 27. The rational number $\frac{1}{2}$ is not a natural
number, so $\mathbf{Q} \not\subset \mathbf{N}$. FALSE | 28. Every integer is a rational number,
so $\mathbf{Z} \subset \mathbf{Q}$. TRUE |
| 29. Every whole number is an integer,
so $\mathbf{W} \subset \mathbf{Z}$. TRUE | 30. The real number $\sqrt{2}$ is not an integer,
so $\mathbf{R} \not\subset \mathbf{Z}$. FALSE | 31. $A \cup B = \{a, b, c, d, e, f, g\}$ | 32. $A \cap B = \{d, e\}$ |
| 33. $A \cap C = \{a, c, e\}$ | 34. $B \cup C = \{a, c, d, e, f, g\}$ | 35. $\frac{9}{16} = 0.5625$; terminates | 36. $\frac{3}{8} = 0.375$; terminates |
| 37. $\frac{3}{11} = 0.272727\dots$; repeats | 38. $\frac{5}{12} = 0.416666\dots$; repeats | 39. natural: 1, 2, 6, 7 | 40. whole: 0, 1, 2, 6, 7 |
| 41. integers: -5, -4, 0, 1, 2, 6, 7 | 42. rational: -5, -4, $-\frac{2}{3}$, 0, 1, 2, 2.75, 6, 7 | 43. irrational: $\sqrt{2}$ | 44. prime: 2, 7 |
| 45. composite: 6 | 46. even: -4, 0, 2, 6 | 47. odd: -5, 1, 7 | 48. negative: -5, -4, $-\frac{2}{3}$ |
| 49.  | 50.  | | |

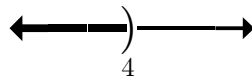
SECTION 0.1



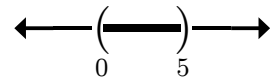
57. $x > 2 \rightarrow (2, \infty)$



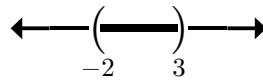
58. $x < 4 \rightarrow (-\infty, 4)$



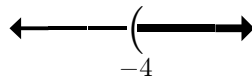
59. $0 < x < 5 \rightarrow (0, 5)$



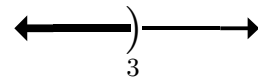
60. $-2 < x < 3 \rightarrow (-2, 3)$



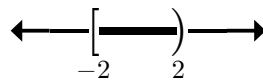
61. $x > -4 \rightarrow (-4, \infty)$



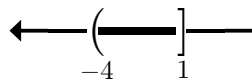
62. $x < 3 \rightarrow (-\infty, 3)$



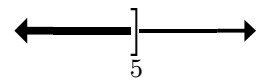
63. $-2 \leq x < 2 \rightarrow [-2, 2)$



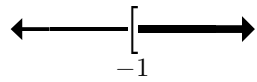
64. $-4 < x \leq 1 \rightarrow (-4, 1]$



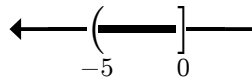
65. $x \leq 5 \rightarrow (-\infty, 5]$



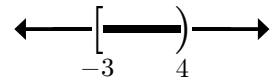
66. $x \geq -1 \rightarrow [-1, \infty)$



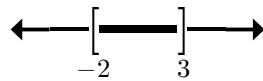
67. $-5 < x \leq 0 \rightarrow (-5, 0]$



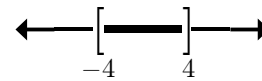
68. $-3 \leq x < 4 \rightarrow [-3, 4)$



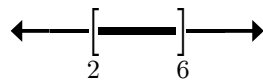
69. $-2 \leq x \leq 3 \rightarrow [-2, 3]$



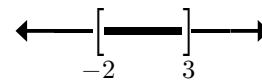
70. $-4 \leq x \leq 4 \rightarrow [-4, 4]$



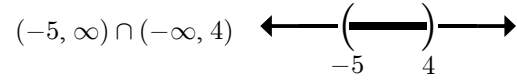
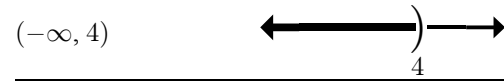
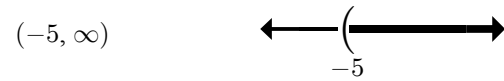
71. $6 \geq x \geq 2 \rightarrow 2 \leq x \leq 6 \rightarrow [2, 6]$



72. $3 \geq x \geq -2 \rightarrow -2 \leq x \leq 3 \rightarrow [-2, 3]$

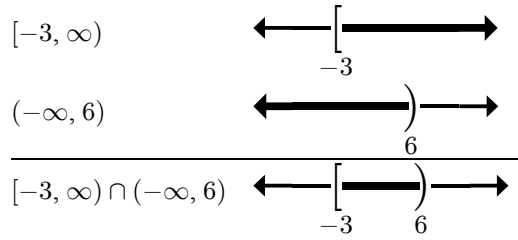


73. $x > -5$ and $x < 4 \rightarrow (-5, \infty) \cap (-\infty, 4)$

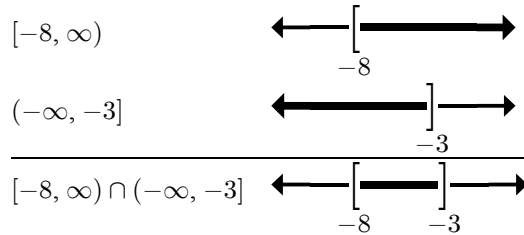


SECTION 0.1

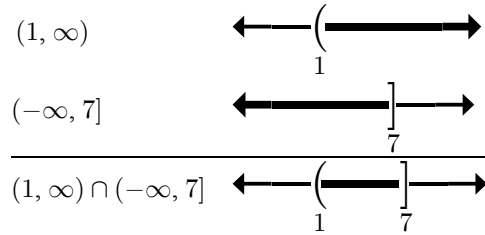
74. $x \geq -3$ and $x < 6 \rightarrow [-3, \infty) \cap (-\infty, 6)$



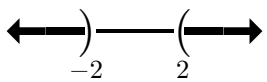
75. $x \geq -8$ and $x \leq -3 \rightarrow [-8, \infty) \cap (-\infty, -3]$



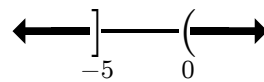
76. $x > 1$ and $x \leq 7 \rightarrow (1, \infty) \cap (-\infty, 7]$



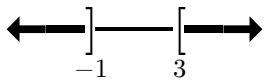
77. $x < -2$ or $x > 2 \rightarrow (-\infty, -2) \cup (2, \infty)$



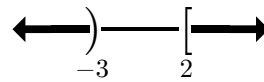
78. $x \leq -5$ or $x > 0 \rightarrow (-\infty, -5] \cup (0, \infty)$



79. $x \leq -1$ or $x \geq 3 \rightarrow (-\infty, -1] \cup [3, \infty)$



80. $x < -3$ or $x \geq 2 \rightarrow (-\infty, -3) \cup [2, \infty)$



81. Since $13 \geq 0$, $|13| = 13$.

82. Since $-17 < 0$, $|-17| = -(-17) = 17$.

83. Since $0 \geq 0$, $|0| = 0$.

84. Since $63 \geq 0$, $|63| = 63$.
 $-|63| = -(63) = -63$

85. Since $-8 < 0$, $|-8| = -(-8) = 8$.
 $-|-8| = -(8) = -8$

86. Since $-25 < 0$, $|-25| = -(-25) = 25$.

SECTION 0.1

- 87.** Since $32 \geq 0$, $|32| = 32$.
 $-|32| = -(32) = -32$
- 89.** Since $\pi - 5 < 0$,
 $|\pi - 5| = -(\pi - 5) = -\pi + 5 = 5 - \pi$.
- 91.** $|\pi - \pi| = |0| = 0$
- 93.** If $x \geq 2$, then $x + 1 \geq 0$. Then
 $|x + 1| = x + 1$.
- 95.** If $x < 0$, then $x - 4 < 0$. Then
 $|x - 4| = -(x - 4)$.
- 97.** distance = $|8 - 3| = |5| = 5$
- 99.** distance = $|-3 - (-8)| = |5| = 5$
- 101.** Since population must be positive and never has a fractional part, the set of **natural numbers** should be used.
- 103.** Since temperatures are usually reported without fractional parts and may be either positive or negative (or zero), the set of **integers** should be used.
- 105.** $-x$ will represent a positive number if x itself is negative. For instance, if $x = -3$, then $-x = -(-3) = 3$, which is a positive number.
- 107.** The statement is always true.
- 109.** The statement is not always true.
(For example, let $a = 5$ and $b = -2$.)
- 111.** The statement $a < b > c$ could be interpreted to mean that $a > c$, when this is not necessarily true.
- 88.** Since $-6 < 0$, $|-6| = -(-6) = 6$.
 $-|-6| = -(6) = -6$
- 90.** Since $8 - \pi \geq 0$, $|8 - \pi| = 8 - \pi$.
- 92.** Since $2\pi \geq 0$, $|2\pi| = 2\pi$.
- 94.** If $x \leq -2$, then $x + 1 < 0$. Then
 $|x + 1| = -(x + 1)$.
- 96.** If $x > 10$, then $x - 7 \geq 0$. Then
 $|x - 7| = x - 7$.
- 98.** distance = $|12 - (-5)| = |17| = 17$
- 100.** distance = $|-20 - 6| = |-26| = 26$
- 102.** Since the subdivisions on a ruler are measured in fractions of an inch, the set of **rational numbers** should be used.
- 104.** Since the financial condition of a business is usually described in terms of dollars and cents (fractional parts of a dollar), the set of **rational numbers** should be used.
- 106.** Every integer is a rational number because every integer is equal to itself over 1.
- 108.** The statement is always true.
- 110.** The statement will be true if
 $a \geq 0$ and $b \geq 0$, or if $a \leq 0$ and $b \leq 0$.
- 112.** $|b - a| = |-1(a - b)| = |-1| \cdot |a - b|$
 $= |a - b|$

Exercises 0.2 (page 24)

1. factor 2. natural 3. 3, $2x$ 4. exponential

SECTION 0.2

5. scientific, integer 6. **Answers may vary.** 7. $x^m x^n = x^{m+n}$ 8. $(x^m)^n = x^{mn}$
9. $(xy)^n = x^n y^n$ 10. $\frac{x^m}{x^n} = x^{m-n}$ 11. $x^0 = 1$ 12. $x^{-n} = \frac{1}{x^n}$
13. $13^2 = 13 \cdot 13 = 169$ 14. $10^3 = 10 \cdot 10 \cdot 10 = 1,000$
15. $-5^2 = -1 \cdot 5 \cdot 5 = -25$ 16. $(-5)^2 = (-5)(-5) = 25$
17. $4x^3 = 4 \cdot x \cdot x \cdot x$ 18. $(4x)^3 = (4x)(4x)(4x)$
19. $(-5x)^4 = (-5x)(-5x)(-5x)(-5x)$ 20. $-6x^2 = -6 \cdot x \cdot x$
21. $-8x^4 = -8 \cdot x \cdot x \cdot x \cdot x$ 22. $(-8x)^4 = (-8x)(-8x)(-8x)(-8x)$
23. $7xxx = 7x^3$ 24. $-8yyyy = -8y^4$
25. $(-x)(-x) = (-1)(-1)x^2 = x^2$ 26. $(2a)(2a)(2a) = 2 \cdot 2 \cdot 2 \cdot a^3 = 8a^3$
27. $(3t)(3t)(-3t) = (3)(3)(-3)t^3 = -27t^3$ 28. $-(2b)(2b)(2b)(2b) = -1 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot b^4 = -16b^4$
29. $xxxxyy = x^3 y^2$ 30. $aaabbbb = a^3 b^4$ 31. $2.2^3 = 10.648$
32. $7.1^4 = 2541.1681$ 33. $-0.5^4 = -0.0625$ 34. $(-0.2)^4 = 0.0016$
35. $x^2 x^3 = x^{2+3} = x^5$ 36. $y^3 y^4 = y^{3+4} = y^7$ 37. $(z^2)^3 = z^{2 \cdot 3} = z^6$
38. $(t^6)^7 = t^{6 \cdot 7} = t^{42}$ 39. $(y^5 y^2)^3 = (y^7)^3 = y^{21}$ 40. $(a^3 a^6) a^4 = a^9 a^4 = a^{13}$
41. $(z^2)^3 (z^4)^5 = z^6 z^{20} = z^{26}$ 42. $(t^3)^4 (t^5)^2 = t^{12} t^{10} = t^{22}$
43. $(a^2)^3 (a^4)^2 = a^6 a^8 = a^{14}$ 44. $(a^2)^4 (a^3)^3 = a^8 a^9 = a^{17}$
45. $(3x)^3 = 3^3 x^3 = 27x^3$ 46. $(-2y)^4 = (-2)^4 y^4 = 16y^4$
47. $(x^2 y)^3 = (x^2)^3 y^3 = x^6 y^3$ 48. $(x^3 z^4)^6 = (x^3)^6 (z^4)^6 = x^{18} z^{24}$
49. $\left(\frac{a^2}{b}\right)^3 = \frac{(a^2)^3}{b^3} = \frac{a^6}{b^3}$ 50. $\left(\frac{x}{y^3}\right)^4 = \frac{x^4}{(y^3)^4} = \frac{x^4}{y^{12}}$
51. $(-x)^0 = 1$ 52. $4x^0 = 4 \cdot 1 = 4$ 53. $(4x)^0 = 1$

SECTION 0.2

54. $-2x^0 = -2 \cdot 1 = -2$ 55. $z^{-4} = \frac{1}{z^4}$ 56. $\frac{1}{t^{-2}} = t^2$
57. $y^{-2}y^{-3} = y^{-5} = \frac{1}{y^5}$ 58. $-m^{-2}m^3 = -m^1 = -m$
59. $(x^3x^{-4})^{-2} = (x^{-1})^{-2} = x^2$ 60. $(y^{-2}y^3)^{-4} = (y^1)^{-4} = y^{-4} = \frac{1}{y^4}$
61. $\frac{x^7}{x^3} = x^{7-3} = x^4$ 62. $\frac{r^5}{r^2} = r^{5-2} = r^3$
63. $\frac{a^{21}}{a^{17}} = a^{21-17} = a^4$ 64. $\frac{t^{13}}{t^4} = t^{13-4} = t^9$
65. $\frac{(x^2)^2}{x^2x} = \frac{x^4}{x^3} = x^{4-3} = x^1 = x$ 66. $\frac{s^9s^3}{(s^2)^2} = \frac{s^{12}}{s^4} = s^{12-4} = s^8$
67. $\left(\frac{m^3}{n^2}\right)^3 = \frac{(m^3)^3}{(n^2)^3} = \frac{m^9}{n^6}$ 68. $\left(\frac{t^4}{t^3}\right)^3 = (t^{4-3})^3 = (t^1)^3 = t^3$
69. $\frac{(a^3)^{-2}}{aa^2} = \frac{a^{-6}}{a^3} = a^{-6-3} = a^{-9} = \frac{1}{a^9}$ 70. $\frac{r^9r^{-3}}{(r^{-2})^3} = \frac{r^6}{r^{-6}} = r^{6-(-6)} = r^{12}$
71. $\left(\frac{a^{-3}}{b^{-1}}\right)^{-4} = \frac{(a^{-3})^{-4}}{(b^{-1})^{-4}} = \frac{a^{12}}{b^4}$ 72. $\left(\frac{t^{-4}}{t^{-3}}\right)^{-2} = \frac{(t^{-4})^{-2}}{(t^{-3})^{-2}} = \frac{t^8}{t^6} = t^2$
73. $\left(\frac{r^4r^{-6}}{r^3r^{-3}}\right)^2 = \left(\frac{r^{-2}}{r^0}\right)^2 = (r^{-2})^2 = r^{-4} = \frac{1}{r^4}$ 74. $\frac{(x^{-3}x^2)^2}{(x^2x^{-5})^{-3}} = \frac{(x^{-1})^2}{(x^{-3})^{-3}} = \frac{x^{-2}}{x^9} = x^{-11} = \frac{1}{x^{11}}$
75. $\left(\frac{x^5y^{-2}}{x^{-3}y^2}\right)^4 = \left(\frac{x^5x^3}{y^2y^2}\right)^4 = \left(\frac{x^8}{y^4}\right)^4 = \frac{x^{32}}{y^{16}}$ 76. $\left(\frac{x^{-7}y^5}{x^7y^{-4}}\right)^3 = \left(\frac{y^5y^4}{x^7x^7}\right)^3 = \left(\frac{y^9}{x^{14}}\right)^3 = \frac{y^{27}}{x^{42}}$
77. $\left(\frac{5x^{-3}y^{-2}}{3x^2y^{-3}}\right)^{-2} = \left(\frac{3x^2y^{-3}}{5x^{-3}y^{-2}}\right)^2 = \left(\frac{3x^2x^3y^2}{5y^3}\right)^2 = \left(\frac{3x^5}{5y}\right)^2 = \frac{9x^{10}}{25y^2}$
78. $\left(\frac{3x^2y^{-5}}{2x^{-2}y^{-6}}\right)^{-3} = \left(\frac{2x^{-2}y^{-6}}{3x^2y^{-5}}\right)^3 = \left(\frac{2y^5}{3x^2x^2y^6}\right)^3 = \left(\frac{2}{3x^4y}\right)^3 = \frac{8}{27x^{12}y^3}$
79. $\left(\frac{3x^5y^{-3}}{6x^{-5}y^3}\right)^{-2} = \left(\frac{6x^{-5}y^3}{3x^5y^{-3}}\right)^2 = \left(\frac{2y^3y^3}{1x^5x^5}\right)^2 = \left(\frac{2y^6}{x^{10}}\right)^2 = \frac{4y^{12}}{x^{20}}$

SECTION 0.2

80. $\left(\frac{12x^{-4}y^3z^{-5}}{4x^4y^{-3}z^5}\right)^3 = \left(\frac{3y^3y^3}{1x^4x^4z^5z^5}\right)^3 = \left(\frac{3y^6}{x^8z^{10}}\right)^3 = \frac{27y^{18}}{x^{24}z^{30}}$
81. $\frac{(8^{-2}z^{-3}y)^{-1}}{(5y^2z^{-2})^3(5yz^{-2})^{-1}} = \frac{8^2z^3y^{-1}}{5^3y^6z^{-6} \cdot 5^{-1}y^{-1}z^2} = \frac{64z^3y^{-1}}{5^2y^5z^{-4}} = \frac{64z^3z^4}{25y^5y^1} = \frac{64z^7}{25y^6}$
82. $\frac{(m^{-2}n^3p^4)^{-2}(mn^{-2}p^3)^4}{(mn^{-2}p^3)^{-4}(mn^2p)^{-1}} = \frac{m^4n^{-6}p^{-8} \cdot m^4n^{-8}p^{12}}{m^{-4}n^8p^{-12} \cdot m^{-1}n^{-2}p^{-1}} = \frac{m^8n^{-14}p^4}{m^{-5}n^6p^{-13}} = \frac{m^8m^5p^4p^{13}}{n^6n^{14}} = \frac{m^{13}p^{17}}{n^{20}}$
83. $-\frac{5[6^2 + (9 - 5)]}{4(2 - 3)^2} = -\frac{5[36 + 4]}{4(-1)^2} = -\frac{5[40]}{4(1)} = -\frac{200}{4} = -50$
84. $\frac{6[3 - (4 - 7)^2]}{-5(2 - 4^2)} = \frac{6[3 - (-3)^2]}{-5(2 - 16)} = \frac{6[3 - 9]}{-5(-14)} = \frac{6[-6]}{70} = \frac{-36}{70} = -\frac{18}{35}$
85. $x^2 = (-2)^2 = 4$
86. $-x^2 = -(-2)^2 = -1 \cdot 4 = -4$
87. $x^3 = (-2)^3 = -8$
88. $-x^3 = -(-2)^3 = -1 \cdot (-8) = 8$
89. $(-xz)^3 = [-1 \cdot (-2) \cdot 3]^3 = 6^3 = 216$
90. $-xz^3 = -1 \cdot (-2) \cdot 3^3 = 2 \cdot 27 = 54$
91. $\frac{-(x^2z^3)}{z^2 - y^2} = \frac{-[(-2)^2 \cdot 3^3]}{3^2 - 0^2} = \frac{-[4 \cdot 27]}{9 - 0} = \frac{-108}{9} = -12$
92. $\frac{z^2(x^2 - y^2)}{x^3z} = \frac{3^2[(-2)^2 - 0^2]}{(-2)^3(3)} = \frac{9(4 - 0)}{(-8)(3)} = \frac{9(4)}{-24} = \frac{36}{-24} = -\frac{3}{2}$
93. $5x^2 - 3y^3z = 5(-2)^2 - 3(0)^3(3) = 5(4) - 3(0)(3) = 20 - 0 = 20$
94. $3(x - z)^2 + 2(y - z)^3 = 3(-2 - 3)^2 + 2(0 - 3)^3 = 3(-5)^2 + 2(-3)^3 = 3(25) + 2(-27) = 75 + (-54) = 21$
95. $\frac{-3x^{-3}z^{-2}}{6x^2z^{-3}} = \frac{-1z^3}{2x^2x^3z^2} = \frac{-z}{2x^5} = \frac{-3}{2(-2)^5} = \frac{-3}{2(-32)} = \frac{-3}{-64} = \frac{3}{64}$
96. $\frac{(-5x^2z^{-3})^2}{5xz^{-2}} = \frac{25x^4z^{-6}}{5xz^{-2}} = \frac{5x^4}{xz^{-2}z^6} = \frac{5x^3}{z^4} = \frac{5(-2)^3}{3^4} = \frac{5(-8)}{81} = \frac{-40}{81} = -\frac{40}{81}$
97. $372,000 = 3.72 \times 10^5$
98. $89,500 = 8.95 \times 10^4$
99. $-177,000,000 = -1.77 \times 10^8$
100. $-23,470,000,000 = -2.347 \times 10^{10}$
101. $0.007 = 7 \times 10^{-3}$
102. $0.00052 = 5.2 \times 10^{-4}$

SECTION 0.2

103. $-0.000000693 = -6.93 \times 10^{-7}$

104. $-0.000000089 = -8.9 \times 10^{-8}$

105. $1,000,000,000,000 = 1 \times 10^{12}$

106. $0.000001 = 1 \times 10^{-6}$

107. $9.37 \times 10^5 = 937,000$

108. $4.26 \times 10^9 = 4,260,000,000$

109. $2.21 \times 10^{-5} = 0.0000221$

110. $2.774 \times 10^{-2} = 0.02774$

111. $0.00032 \times 10^4 = 3.2$

112. $9,300.0 \times 10^{-4} = 0.93$

113. $-3.2 \times 10^{-3} = -0.0032$

114. $-7.25 \times 10^3 = -7,250$

115.
$$\frac{(65,000)(45,000)}{250,000} = \frac{(6.5 \times 10^4)(4.5 \times 10^4)}{2.5 \times 10^5} = \frac{(6.5)(4.5)}{2.5} \times 10^{4+4-5} = 11.7 \times 10^3$$

$$= 1.17 \times 10^1 \times 10^3$$

$$= 1.17 \times 10^4$$

116.
$$\frac{(0.000000045)(0.00000012)}{45,000,000} = \frac{(4.5 \times 10^{-8})(1.2 \times 10^{-7})}{4.5 \times 10^7} = \frac{(4.5)(1.2)}{4.5} \times 10^{(-8)+(-7)-7}$$

$$= 1.2 \times 10^{-22}$$

117.
$$\frac{(0.00000035)(170,000)}{0.00000085} = \frac{(3.5 \times 10^{-7})(1.7 \times 10^5)}{8.5 \times 10^{-7}} = \frac{(3.5)(1.7)}{8.5} \times 10^{(-7)+5-(-7)}$$

$$= 0.7 \times 10^5$$

$$= 7 \times 10^{-1} \times 10^5 = 7 \times 10^4$$

118.
$$\frac{(0.0000000144)(12,000)}{600,000} = \frac{(1.44 \times 10^{-8})(1.2 \times 10^4)}{6 \times 10^5} = \frac{(1.44)(1.2)}{6} \times 10^{(-8)+4-5}$$

$$= 0.288 \times 10^{-9}$$

$$= 2.88 \times 10^{-1} \times 10^{-9} = 2.88 \times 10^{-10}$$

119.
$$\frac{(45,000,000,000)(212,000)}{0.00018} = \frac{(4.5 \times 10^{10})(2.12 \times 10^5)}{1.8 \times 10^{-4}} = \frac{(4.5)(2.12)}{1.8} \times 10^{10+5-(-4)}$$

$$= 5.3 \times 10^{19}$$

120.
$$\frac{(0.00000000275)(4,750)}{500,000,000,000} = \frac{(2.75 \times 10^{-9})(4.75 \times 10^3)}{5 \times 10^{11}} = \frac{(2.75)(4.75)}{5} \times 10^{(-9)+3-11}$$

$$= 2.6125 \times 10^{-17}$$

121.
$$3.31 \times 10^4 \text{ cm/sec} = \frac{3.31 \times 10^4 \text{ cm}}{1 \text{ sec}} \cdot \frac{1 \text{ m}}{100 \text{ cm}} \cdot \frac{60 \text{ sec}}{1 \text{ min}} = \frac{(3.31 \times 10^4)(6 \times 10^1)}{1 \times 10^2} \text{ m/min}$$

$$= \frac{(3.31)(6)}{1} \times 10^{4+1-2} \text{ m/min}$$

$$= 19.86 \times 10^3 \text{ m/min}$$

$$= 1.986 \times 10^4 \text{ m/min}$$

SECTION 0.2

$$137. (-2, 4) \Rightarrow \left(\begin{array}{c} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \\ -2 \qquad \qquad \qquad 4 \end{array} \right)$$

$$138. (-\infty, -3] \cup [3, \infty) \Rightarrow \left(\begin{array}{c} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \text{---} \\ -3 \qquad \qquad \qquad 3 \end{array} \right)$$

$$139. \text{ Since } \pi - 5 < 0, \\ |\pi - 5| = -(\pi - 5) = -\pi + 5 = 5 - \pi.$$

$$140. \text{ distance} = |-5 - (-7)| = |2| = 2$$

Exercises 0.3 (page 38)

1. 0

2. positive

3. not

4. $(6^2)^{1/3}, (6^{1/3})^2$

5. $a^{1/n}$

6. $|a|$

7. $\sqrt[n]{ab}$

8. $\frac{\sqrt[n]{a}}{\sqrt[n]{b}}$

9. \neq

10. $\sqrt[n]{x}$

11. $9^{1/2} = (3^2)^{1/2} = 3$

12. $8^{1/3} = (2^3)^{1/3} = 2$

13. $\left(\frac{1}{25}\right)^{1/2} = \left[\left(\frac{1}{5}\right)^2\right]^{1/2} = \frac{1}{5}$

14. $\left(\frac{16}{625}\right)^{1/4} = \left[\left(\frac{2}{5}\right)^4\right]^{1/4} = \frac{2}{5}$

15. $-81^{1/4} = -(3^4)^{1/4} = -3$

16. $-\left(\frac{8}{27}\right)^{1/3} = -\left[\left(\frac{2}{3}\right)^3\right]^{1/3} = -\frac{2}{3}$

17. $(10,000)^{1/4} = (10^4)^{1/4} = 10$

18. $(1,024)^{1/5} = (4^5)^{1/5} = 4$

19. $\left(-\frac{27}{8}\right)^{1/3} = \left[\left(-\frac{3}{2}\right)^3\right]^{1/3} = -\frac{3}{2}$

20. $-64^{1/3} = -(4^3)^{1/3} = -4$

21. $(-64)^{1/2} \Rightarrow$ not a real number

22. $(-125)^{1/3} = [(-5)^3]^{1/3} = -5$

23. $(16a^2)^{1/2} = [(4a)^2]^{1/2} = 4|a|$

24. $(25a^4)^{1/2} = [(5a^2)^2]^{1/2} = 5|a^2| = 5a^2$

25. $(16a^4)^{1/4} = [(2a)^4]^{1/4} = 2|a|$

26. $(-64a^3)^{1/3} = [(-4a)^3]^{1/3} = -4a$

27. $(-32a^5)^{1/5} = [(-2a)^5]^{1/5} = -2a$

28. $(64a^6)^{1/6} = [(2a)^6]^{1/6} = 2|a|$

29. $(-216b^6)^{1/3} = [(-6b^2)^3]^{1/3} = -6b^2$

30. $(256t^8)^{1/4} = [(4t^2)^4]^{1/4} = 4|t^2| = 4t^2$

SECTION 0.3

31. $\left(\frac{16a^4}{25b^2}\right)^{1/2} = \left[\left(\frac{4a^2}{5b}\right)^2\right]^{1/2} = \left|\frac{4a^2}{5b}\right|$
 $= \frac{4a^2}{5|b|}$
32. $\left(-\frac{a^5}{32b^{10}}\right)^{1/5} = \left[\left(-\frac{a}{2b^2}\right)^5\right]^{1/5} = -\frac{a}{2b^2}$
33. $\left(-\frac{1,000x^6}{27y^3}\right)^{1/3} = \left[\left(-\frac{10x^2}{3y}\right)^3\right]^{1/3}$
 $= -\frac{10x^2}{3y}$
34. $\left(\frac{49t^2}{100z^4}\right)^{1/2} = \left[\left(\frac{7t}{10z^2}\right)^2\right]^{1/2} = \left|\frac{7t}{10z^2}\right|$
 $= \frac{7|t|}{10z^2}$
35. $4^{3/2} = (4^{1/2})^3 = 2^3 = 8$
36. $8^{2/3} = (8^{1/3})^2 = 2^2 = 4$
37. $-16^{3/2} = -(16^{1/2})^3 = -(4)^3 = -64$
38. $(-8)^{2/3} = [(-8)^{1/3}]^2 = (-2)^2 = 4$
39. $-1,000^{2/3} = -(1,000^{1/3})^2 = -(10)^2$
 $= -100$
40. $100^{3/2} = (100^{1/2})^3 = 10^3 = 1,000$
41. $64^{-1/2} = \frac{1}{64^{1/2}} = \frac{1}{8}$
42. $25^{-1/2} = \frac{1}{25^{1/2}} = \frac{1}{5}$
43. $64^{-3/2} = \frac{1}{64^{3/2}} = \frac{1}{(64^{1/2})^3} = \frac{1}{8^3} = \frac{1}{512}$
44. $49^{-3/2} = \frac{1}{49^{3/2}} = \frac{1}{(49^{1/2})^3} = \frac{1}{7^3} = \frac{1}{343}$
45. $-9^{-3/2} = -\frac{1}{9^{3/2}} = -\frac{1}{(9^{1/2})^3} = -\frac{1}{3^3}$
 $= -\frac{1}{27}$
46. $(-27)^{-2/3} = \frac{1}{(-27)^{2/3}} = \frac{1}{\left[(-27)^{1/3}\right]^2}$
 $= \frac{1}{(-3)^2} = \frac{1}{9}$
47. $\left(\frac{4}{9}\right)^{5/2} = \left[\left(\frac{4}{9}\right)^{1/2}\right]^5 = \left(\frac{2}{3}\right)^5 = \frac{32}{243}$
48. $\left(\frac{25}{81}\right)^{3/2} = \left[\left(\frac{25}{81}\right)^{1/2}\right]^3 = \left(\frac{5}{9}\right)^3 = \frac{125}{729}$
49. $\left(-\frac{27}{64}\right)^{-2/3} = \left(-\frac{64}{27}\right)^{2/3} = \left[\left(-\frac{64}{27}\right)^{1/3}\right]^2 = \left(-\frac{4}{3}\right)^2 = \frac{16}{9}$
50. $\left(\frac{125}{8}\right)^{-4/3} = \left(\frac{8}{125}\right)^{4/3} = \left[\left(\frac{8}{125}\right)^{1/3}\right]^4 = \left(\frac{2}{5}\right)^4 = \frac{16}{625}$
51. $(100s^4)^{1/2} = 100^{1/2}(s^4)^{1/2} = 10s^2$
52. $(64u^6v^3)^{1/3} = 64^{1/3}(u^6)^{1/3}(v^3)^{1/3} = 4u^2v$

SECTION 0.3

$$53. (32y^{10}z^5)^{-1/5} = \frac{1}{(32y^{10}z^5)^{1/5}} = \frac{1}{32^{1/5}(y^{10})^{1/5}(z^5)^{1/5}} = \frac{1}{2y^2z}$$

$$54. (625a^4b^8)^{-1/4} = \frac{1}{(625a^4b^8)^{1/4}} = \frac{1}{625^{1/4}(a^4)^{1/4}(b^8)^{1/4}} = \frac{1}{5ab^2}$$

$$55. (x^{10}y^5)^{3/5} = x^{30/5}y^{15/5} = x^6y^3$$

$$56. (64a^6b^{12})^{5/6} = 64^{5/6}a^{30/6}b^{60/6} = (64^{1/6})^5a^5b^{10} = 2^5a^5b^{10} = 32a^5b^{10}$$

$$57. (r^8s^{16})^{-3/4} = r^{-24/4}s^{-48/4} = r^{-6}s^{-12} = \frac{1}{r^6s^{12}}$$

$$58. (-8x^9y^{12})^{-2/3} = (-8)^{-2/3}x^{-18/3}y^{-24/3} = \frac{1}{(-8)^{2/3}}x^{-6}y^{-8} = \frac{1}{(-2)^2x^6y^8} = \frac{1}{4x^6y^8}$$

$$59. \left(-\frac{8a^6}{125b^9}\right)^{2/3} = \frac{(-8)^{2/3}a^{12/3}}{125^{2/3}b^{18/3}} = \frac{(-2)^2a^4}{5^2b^6} = \frac{4a^4}{25b^6}$$

$$60. \left(\frac{16x^4}{625y^8}\right)^{3/4} = \frac{16^{3/4}x^{12/4}}{625^{3/4}y^{24/4}} = \frac{2^3x^3}{5^3y^6} = \frac{8x^3}{125y^6}$$

$$61. \left(\frac{27r^6}{1,000s^{12}}\right)^{-2/3} = \left(\frac{1,000s^{12}}{27r^6}\right)^{2/3} = \frac{1,000^{2/3}s^{24/3}}{27^{2/3}r^{12/3}} = \frac{10^2s^8}{3^2r^4} = \frac{100s^8}{9r^4}$$

$$62. \left(-\frac{32m^{10}}{243n^{15}}\right)^{-2/5} = \left(\frac{-243n^{15}}{32m^{10}}\right)^{2/5} = \frac{(-243)^{2/5}n^{30/5}}{32^{2/5}m^{20/5}} = \frac{(-3)^2n^6}{2^2m^4} = \frac{9n^6}{4m^4}$$

$$63. \frac{a^{2/5}a^{4/5}}{a^{1/5}} = \frac{a^{6/5}}{a^{1/5}} = a^{5/5} = a$$

$$64. \frac{x^{6/7}x^{3/7}}{x^{2/7}x^{5/7}} = \frac{x^{9/7}}{x^{7/7}} = x^{2/7}$$

$$65. \sqrt{49} = \sqrt{7^2} = 7$$

$$66. \sqrt{81} = \sqrt{9^2} = 9$$

$$67. \sqrt[3]{125} = \sqrt[3]{5^3} = 5$$

$$68. \sqrt[3]{-64} = \sqrt[3]{(-4)^3} = -4$$

$$69. \sqrt[3]{-125} = \sqrt[3]{(-5)^3} = -5$$

$$70. \sqrt[5]{-243} = \sqrt[5]{(-3)^5} = -3$$

$$71. \sqrt[5]{-\frac{32}{100,000}} = \sqrt[5]{\left(-\frac{2}{10}\right)^5} = -\frac{2}{10} = -\frac{1}{5}$$

$$72. \sqrt[4]{\frac{256}{625}} = \sqrt[4]{\left(\frac{4}{5}\right)^4} = \frac{4}{5}$$

$$73. \sqrt{36x^2} = \sqrt{(6x)^2} = |6x| = 6|x|$$

$$74. -\sqrt{25y^2} = -\sqrt{(5y)^2} = -|5y| = -5|y|$$

SECTION 0.3

$$75. \sqrt{9y^4} = \sqrt{(3y^2)^2} = |3y^2| = 3y^2 \qquad 76. \sqrt{a^4b^8} = \sqrt{(a^2b^4)^2} = |a^2b^4| = a^2b^4$$

$$77. \sqrt[3]{8y^3} = \sqrt[3]{(2y)^3} = 2y \qquad 78. \sqrt[3]{-27z^9} = \sqrt[3]{(-3z^3)^3} = -3z^3$$

$$79. \sqrt[4]{\frac{x^4y^8}{z^{12}}} = \sqrt[4]{\left(\frac{xy^2}{z^3}\right)^4} = \left|\frac{xy^2}{z^3}\right| = \frac{|x|y^2}{|z^3|} \qquad 80. \sqrt[5]{\frac{a^{10}b^5}{c^{15}}} = \sqrt[5]{\left(\frac{a^2b}{c^3}\right)^5} = \frac{a^2b}{c^3}$$

$$81. \sqrt{8} - \sqrt{2} = \sqrt{4}\sqrt{2} - \sqrt{2} = 2\sqrt{2} - \sqrt{2} = \sqrt{2}$$

$$82. \sqrt{75} - 2\sqrt{27} = \sqrt{25}\sqrt{3} - 2\sqrt{9}\sqrt{3} = 5\sqrt{3} - 2(3)\sqrt{3} = 5\sqrt{3} - 6\sqrt{3} = -\sqrt{3}$$

$$83. \sqrt{200x^2} + \sqrt{98x^2} = \sqrt{100x^2}\sqrt{2} + \sqrt{49x^2}\sqrt{2} = 10x\sqrt{2} + 7x\sqrt{2} = 17x\sqrt{2}$$

$$84. \sqrt{128a^3} - a\sqrt{162a} = \sqrt{64a^2}\sqrt{2a} - a\sqrt{81}\sqrt{2a} = 8a\sqrt{2a} - 9a\sqrt{2a} = -a\sqrt{2a}$$

$$85. \begin{aligned} 2\sqrt{48y^5} - 3y\sqrt{12y^3} &= 2\sqrt{16y^4}\sqrt{3y} - 3y\sqrt{4y^2}\sqrt{3y} = 2(4y^2)\sqrt{3y} - 3y(2y)\sqrt{3y} \\ &= 8y^2\sqrt{3y} - 6y^2\sqrt{3y} = 2y^2\sqrt{3y} \end{aligned}$$

$$86. \begin{aligned} y\sqrt{112y} + 4\sqrt{175y^3} &= y\sqrt{16}\sqrt{7y} + 4\sqrt{25y^2}\sqrt{7y} = y(4)\sqrt{7y} + 4(5y)\sqrt{7y} \\ &= 4y\sqrt{7y} + 20y\sqrt{7y} = 24y\sqrt{7y} \end{aligned}$$

$$87. 2\sqrt[3]{81} + 3\sqrt[3]{24} = 2\sqrt[3]{27}\sqrt[3]{3} + 3\sqrt[3]{8}\sqrt[3]{3} = 2(3)\sqrt[3]{3} + 3(2)\sqrt[3]{3} = 6\sqrt[3]{3} + 6\sqrt[3]{3} = 12\sqrt[3]{3}$$

$$88. 3\sqrt[4]{32} - 2\sqrt[4]{162} = 3\sqrt[4]{16}\sqrt[4]{2} - 2\sqrt[4]{81}\sqrt[4]{2} = 3(2)\sqrt[4]{2} - 2(3)\sqrt[4]{2} = 6\sqrt[4]{2} - 6\sqrt[4]{2} = 0$$

$$89. \sqrt[4]{768z^5} + \sqrt[4]{48z^5} = \sqrt[4]{256z^4}\sqrt[4]{3z} + \sqrt[4]{16z^4}\sqrt[4]{3z} = 4z\sqrt[4]{3z} + 2z\sqrt[4]{3z} = 6z\sqrt[4]{3z}$$

$$90. \begin{aligned} -2\sqrt[5]{64y^2} + 3\sqrt[5]{486y^2} &= -2\sqrt[5]{32}\sqrt[5]{2y^2} + 3\sqrt[5]{243}\sqrt[5]{2y^2} = -2(2)\sqrt[5]{2y^2} + 3(3)\sqrt[5]{2y^2} \\ &= -4\sqrt[5]{2y^2} + 9\sqrt[5]{2y^2} = 5\sqrt[5]{2y^2} \end{aligned}$$

$$91. \begin{aligned} \sqrt{8x^2y} - x\sqrt{2y} + \sqrt{50x^2y} &= \sqrt{4x^2}\sqrt{2y} - x\sqrt{2y} + \sqrt{25x^2}\sqrt{2y} \\ &= 2x\sqrt{2y} - x\sqrt{2y} + 5x\sqrt{2y} = 6x\sqrt{2y} \end{aligned}$$

$$92. \begin{aligned} 3x\sqrt{18x} + 2\sqrt{2x^3} - \sqrt{72x^3} &= 3x\sqrt{9}\sqrt{2x} + 2\sqrt{x^2}\sqrt{2x} - \sqrt{36x^2}\sqrt{2x} \\ &= 3x(3)\sqrt{2x} + 2x\sqrt{2x} - 6x\sqrt{2x} \\ &= 9x\sqrt{2x} + 2x\sqrt{2x} - 6x\sqrt{2x} = 5x\sqrt{2x} \end{aligned}$$

$$93. \begin{aligned} \sqrt[3]{16xy^4} + y\sqrt[3]{2xy} - \sqrt[3]{54xy^4} &= \sqrt[3]{8y^3}\sqrt[3]{2xy} + y\sqrt[3]{2xy} - \sqrt[3]{27y^3}\sqrt[3]{2xy} \\ &= 2y\sqrt[3]{2xy} + y\sqrt[3]{2xy} - 3y\sqrt[3]{2xy} = 0 \end{aligned}$$

SECTION 0.3

$$94. \quad \sqrt[4]{512x^5} - \sqrt[4]{32x^5} + \sqrt[4]{1,250x^5} = \sqrt[4]{256x^4}\sqrt[4]{2x} - \sqrt[4]{16x^4}\sqrt[4]{2x} + \sqrt[4]{625x^4}\sqrt[4]{2x} \\ = 4x\sqrt[4]{2x} - 2x\sqrt[4]{2x} + 5x\sqrt[4]{2x} = 7x\sqrt[4]{2x}$$

$$95. \quad \frac{3}{\sqrt{3}} = \frac{3}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{3\sqrt{3}}{3} = \sqrt{3}$$

$$96. \quad \frac{6}{\sqrt{5}} = \frac{6}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{6\sqrt{5}}{5}$$

$$97. \quad \frac{2}{\sqrt{x}} = \frac{2}{\sqrt{x}} \cdot \frac{\sqrt{x}}{\sqrt{x}} = \frac{2\sqrt{x}}{x}$$

$$98. \quad \frac{8}{\sqrt{y}} = \frac{8}{\sqrt{y}} \cdot \frac{\sqrt{y}}{\sqrt{y}} = \frac{8\sqrt{y}}{y}$$

$$99. \quad \frac{2}{\sqrt[3]{2}} = \frac{2}{\sqrt[3]{2}} \cdot \frac{\sqrt[3]{4}}{\sqrt[3]{4}} = \frac{2\sqrt[3]{4}}{\sqrt[3]{8}} = \frac{2\sqrt[3]{4}}{2} = \sqrt[3]{4}$$

$$100. \quad \frac{4d}{\sqrt[3]{9}} = \frac{4d}{\sqrt[3]{9}} \cdot \frac{\sqrt[3]{3}}{\sqrt[3]{3}} = \frac{4d\sqrt[3]{3}}{\sqrt[3]{27}} = \frac{4d\sqrt[3]{3}}{3}$$

$$101. \quad \frac{5a}{\sqrt[3]{25a}} = \frac{5a}{\sqrt[3]{25a}} \cdot \frac{\sqrt[3]{5a^2}}{\sqrt[3]{5a^2}} = \frac{5a\sqrt[3]{5a^2}}{\sqrt[3]{125a^3}} = \frac{5a\sqrt[3]{5a^2}}{5a} = \sqrt[3]{5a^2}$$

$$102. \quad \frac{7}{\sqrt[3]{36c}} = \frac{7}{\sqrt[3]{36c}} \cdot \frac{\sqrt[3]{6c^2}}{\sqrt[3]{6c^2}} = \frac{7\sqrt[3]{6c^2}}{\sqrt[3]{216c^3}} = \frac{7\sqrt[3]{6c^2}}{6c}$$

$$103. \quad \frac{2b}{\sqrt[4]{3a^2}} = \frac{2b}{\sqrt[4]{3a^2}} \cdot \frac{\sqrt[4]{27a^2}}{\sqrt[4]{27a^2}} = \frac{2b\sqrt[4]{27a^2}}{\sqrt[4]{81a^4}} = \frac{2b\sqrt[4]{27a^2}}{3a}$$

$$104. \quad \sqrt{\frac{x}{2y}} = \frac{\sqrt{x}}{\sqrt{2y}} = \frac{\sqrt{x}}{\sqrt{2y}} \cdot \frac{\sqrt{2y}}{\sqrt{2y}} = \frac{\sqrt{2xy}}{2y}$$

$$105. \quad \sqrt[3]{\frac{2u^4}{9v}} = \frac{\sqrt[3]{2u^4}}{\sqrt[3]{9v}} = \frac{\sqrt[3]{u^3}\sqrt[3]{2u}}{\sqrt[3]{9v}} \cdot \frac{\sqrt[3]{3v^2}}{\sqrt[3]{3v^2}} = \frac{u\sqrt[3]{6uv^2}}{\sqrt[3]{27v^3}} = \frac{u\sqrt[3]{6uv^2}}{3v}$$

$$106. \quad \sqrt[3]{\frac{-3s^5}{4r^2}} = \frac{\sqrt[3]{-3s^5}}{\sqrt[3]{4r^2}} = \frac{\sqrt[3]{-s^3}\sqrt[3]{3s^2}}{\sqrt[3]{4r^2}} \cdot \frac{\sqrt[3]{2r}}{\sqrt[3]{2r}} = \frac{-s\sqrt[3]{6rs^2}}{\sqrt[3]{8r^3}} = -\frac{s\sqrt[3]{6rs^2}}{2r}$$

$$107. \quad \frac{\sqrt{5}}{10} = \frac{\sqrt{5}}{10} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{5}{10\sqrt{5}} = \frac{1}{2\sqrt{5}}$$

$$108. \quad \frac{\sqrt{y}}{3} = \frac{\sqrt{y}}{3} \cdot \frac{\sqrt{y}}{\sqrt{y}} = \frac{y}{3\sqrt{y}}$$

$$109. \quad \frac{\sqrt[3]{9}}{3} = \frac{\sqrt[3]{9}}{3} \cdot \frac{\sqrt[3]{3}}{\sqrt[3]{3}} = \frac{\sqrt[3]{27}}{3\sqrt[3]{3}} = \frac{3}{3\sqrt[3]{3}} = \frac{1}{\sqrt[3]{3}}$$

$$110. \quad \frac{\sqrt[3]{16b^2}}{16} = \frac{\sqrt[3]{16b^2}}{16} \cdot \frac{\sqrt[3]{4b}}{\sqrt[3]{4b}} = \frac{\sqrt[3]{64b^3}}{16\sqrt[3]{4b}} = \frac{4b}{16\sqrt[3]{4b}} = \frac{b}{4\sqrt[3]{4b}}$$

$$111. \quad \frac{\sqrt[5]{16b^3}}{64a} = \frac{\sqrt[5]{16b^3}}{64a} \cdot \frac{\sqrt[5]{2b^2}}{\sqrt[5]{2b^2}} = \frac{\sqrt[5]{32b^5}}{64a\sqrt[5]{2b^2}} = \frac{2b}{64a\sqrt[5]{2b^2}} = \frac{b}{32a\sqrt[5]{2b^2}}$$

SECTION 0.3

$$112. \sqrt{\frac{3x}{57}} = \frac{\sqrt{3x}}{\sqrt{57}} = \frac{\sqrt{3x}}{\sqrt{57}} \cdot \frac{\sqrt{3x}}{\sqrt{3x}} = \frac{3x}{\sqrt{171x}} = \frac{3x}{\sqrt{9}\sqrt{19x}} = \frac{3x}{3\sqrt{19x}} = \frac{x}{\sqrt{19x}}$$

$$113. \sqrt{\frac{1}{3}} - \sqrt{\frac{1}{27}} = \frac{\sqrt{1}}{\sqrt{3}} - \frac{\sqrt{1}}{\sqrt{27}} = \frac{1}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} - \frac{1}{\sqrt{27}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{\sqrt{3}}{3} - \frac{\sqrt{3}}{\sqrt{81}} = \frac{\sqrt{3}}{3} - \frac{\sqrt{3}}{9} \\ = \frac{3\sqrt{3}}{9} - \frac{\sqrt{3}}{9} = \frac{2\sqrt{3}}{9}$$

$$114. \sqrt[3]{\frac{1}{2}} + \sqrt[3]{\frac{1}{16}} = \frac{\sqrt[3]{1}}{\sqrt[3]{2}} + \frac{\sqrt[3]{1}}{\sqrt[3]{16}} = \frac{1}{\sqrt[3]{2}} \cdot \frac{\sqrt[3]{4}}{\sqrt[3]{4}} + \frac{1}{\sqrt[3]{16}} \cdot \frac{\sqrt[3]{4}}{\sqrt[3]{4}} = \frac{\sqrt[3]{4}}{\sqrt[3]{8}} + \frac{\sqrt[3]{4}}{\sqrt[3]{64}} = \frac{\sqrt[3]{4}}{2} + \frac{\sqrt[3]{4}}{4} \\ = \frac{2\sqrt[3]{4}}{4} + \frac{\sqrt[3]{4}}{4} = \frac{3\sqrt[3]{4}}{4}$$

$$115. \sqrt{\frac{x}{8}} - \sqrt{\frac{x}{2}} + \sqrt{\frac{x}{32}} = \frac{\sqrt{x}}{\sqrt{8}} - \frac{\sqrt{x}}{\sqrt{2}} + \frac{\sqrt{x}}{\sqrt{32}} = \frac{\sqrt{x}}{\sqrt{8}} \cdot \frac{\sqrt{2}}{\sqrt{2}} - \frac{\sqrt{x}}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} + \frac{\sqrt{x}}{\sqrt{32}} \cdot \frac{\sqrt{2}}{\sqrt{2}} \\ = \frac{\sqrt{2x}}{\sqrt{16}} - \frac{\sqrt{2x}}{\sqrt{4}} + \frac{\sqrt{2x}}{\sqrt{64}} \\ = \frac{\sqrt{2x}}{4} - \frac{\sqrt{2x}}{2} + \frac{\sqrt{2x}}{8} \\ = \frac{2\sqrt{2x}}{8} - \frac{4\sqrt{2x}}{8} + \frac{\sqrt{2x}}{8} = -\frac{\sqrt{2x}}{8}$$

$$116. \sqrt[3]{\frac{y}{4}} + \sqrt[3]{\frac{y}{32}} - \sqrt[3]{\frac{y}{500}} = \frac{\sqrt[3]{y}}{\sqrt[3]{4}} + \frac{\sqrt[3]{y}}{\sqrt[3]{32}} - \frac{\sqrt[3]{y}}{\sqrt[3]{500}} = \frac{\sqrt[3]{y}}{\sqrt[3]{4}} \cdot \frac{\sqrt[3]{2}}{\sqrt[3]{2}} + \frac{\sqrt[3]{y}}{\sqrt[3]{32}} \cdot \frac{\sqrt[3]{2}}{\sqrt[3]{2}} - \frac{\sqrt[3]{y}}{\sqrt[3]{500}} \cdot \frac{\sqrt[3]{2}}{\sqrt[3]{2}} \\ = \frac{\sqrt[3]{2y}}{\sqrt[3]{8}} + \frac{\sqrt[3]{2y}}{\sqrt[3]{64}} - \frac{\sqrt[3]{2y}}{\sqrt[3]{1,000}} \\ = \frac{\sqrt[3]{2y}}{2} + \frac{\sqrt[3]{2y}}{4} - \frac{\sqrt[3]{2y}}{10} \\ = \frac{10\sqrt[3]{2y}}{20} + \frac{5\sqrt[3]{2y}}{20} - \frac{2\sqrt[3]{2y}}{20} = \frac{13\sqrt[3]{2y}}{20}$$

$$117. \sqrt[4]{9} = 9^{1/4} = (3^2)^{1/4} = 3^{2/4} = 3^{1/2} = \sqrt{3}$$

$$118. \sqrt[6]{27} = 27^{1/6} = (3^3)^{1/6} = 3^{3/6} = 3^{1/2} = \sqrt{3}$$

$$119. \sqrt[10]{16x^6} = (16x^6)^{1/10} = (2^4x^6)^{1/10} = 2^{4/10}x^{6/10} = 2^{2/5}x^{3/5} = (2^2x^3)^{1/5} = \sqrt[5]{4x^3}$$

$$120. \sqrt[6]{27x^9} = (27x^9)^{1/6} = (3^3x^9)^{1/6} = 3^{3/6}x^{9/6} = 3^{1/2}x^{3/2} = (3x^3)^{1/2} = \sqrt{3x^3} = x\sqrt{3x}$$

$$121. \sqrt{2}\sqrt[3]{2} = 2^{1/2} \cdot 2^{1/3} = 2^{3/6} \cdot 2^{2/6} = \sqrt[6]{2^3}\sqrt[6]{2^2} = \sqrt[6]{8}\sqrt[6]{4} = \sqrt[6]{32}$$

$$122. \sqrt{3}\sqrt[3]{5} = 3^{1/2}5^{1/3} = 3^{3/6}5^{2/6} = \sqrt[6]{3^3}\sqrt[6]{5^2} = \sqrt[6]{27}\sqrt[6]{25} = \sqrt[6]{675}$$

SECTION 0.3

$$123. \frac{\sqrt[4]{3}}{\sqrt{2}} = \frac{3^{1/4}}{2^{1/2}} = \frac{3^{1/4}}{2^{2/4}} = \frac{\sqrt[4]{3}}{\sqrt[4]{2^2}} = \frac{\sqrt[4]{3}}{\sqrt[4]{4}} = \frac{\sqrt[4]{3}}{\sqrt[4]{4}} \cdot \frac{\sqrt[4]{4}}{\sqrt[4]{4}} = \frac{\sqrt[4]{12}}{\sqrt[4]{16}} = \frac{\sqrt[4]{12}}{2}$$

$$124. \frac{\sqrt[3]{2}}{\sqrt{5}} = \frac{2^{1/3}}{5^{1/2}} = \frac{2^{2/6}}{5^{3/6}} = \frac{\sqrt[6]{2^2}}{\sqrt[6]{5^3}} = \frac{\sqrt[6]{4}}{\sqrt[6]{125}} = \frac{\sqrt[6]{4}}{\sqrt[6]{125}} \cdot \frac{\sqrt[6]{125}}{\sqrt[6]{125}} = \frac{\sqrt[6]{500}}{\sqrt[6]{15,625}} = \frac{\sqrt[6]{500}}{5}$$

$$125. \sqrt[4]{x^4} = |x|. \text{ Since } |x| = x \text{ if } x \geq 0, \text{ then } \sqrt[4]{x^4} = x \text{ if } x \geq 0.$$

$$126. \sqrt[n]{\frac{x}{y}} = \left(\frac{x}{y}\right)^{1/n} = \frac{x^{1/n}}{y^{1/n}} = \frac{\sqrt[n]{x}}{\sqrt[n]{y}}$$

$$127. \left(\frac{x}{y}\right)^{-m/n} = \frac{x^{-m/n}}{y^{-m/n}} = \frac{x^{-m/n}}{y^{-m/n}} \cdot \frac{x^{m/n}y^{m/n}}{x^{m/n}y^{m/n}} = \frac{y^{m/n}}{x^{m/n}} = \frac{(y^m)^{1/n}}{(x^m)^{1/n}} = \left(\frac{y^m}{x^m}\right)^{1/n} = \sqrt[n]{\frac{y^m}{x^m}}$$

128. Consider the case when n is even, m is odd and x is negative. Then $x^{m/n} = (x^{1/n})^m = (\sqrt[n]{x})^m$. Thus, $\sqrt[n]{x}$ must be a real number for the expression to be defined.

$$129. -2 < x \leq 5 \Rightarrow (-2, 5] \qquad 130. \text{ If } x > 4, \text{ then } 3 - x < 0. \text{ Then } |3 - x| = -(3 - x) = -3 + x = x - 3.$$

$$131. x^2 - y^2 = (-2)^2 - 3^2 = 4 - 9 = -5$$

$$132. \frac{xy + 4y}{x} = \frac{-2(3) + 4(3)}{-2} = \frac{-6 + 12}{-2} = \frac{6}{-2} = -3$$

$$133. 617,000,000 = 6.17 \times 10^8 \qquad 134. 0.00235 \times 10^4 = 23.5$$

Exercises 0.4 (page 50)

- | | | | |
|---|-------------------------------|--------------------------------|-------------|
| 1. monomial, variables | 2. degree, variables | 3. trinomial | 4. binomial |
| 5. one | 6. zero | 7. like | 8. degree |
| 9. coefficients, variables | 10. $3\sqrt{x} - 2$ | 11. yes, trinomial, 2nd degree | |
| 12. yes, binomial, 3rd degree | 13. no | 14. no | |
| 15. yes, binomial, 3rd degree | 16. yes, monomial, 5th degree | 17. yes, monomial, 0th degree | |
| 18. no | 19. yes, monomial, no degree | 20. yes, none, 3rd degree | |
| 21. $(x^3 - 3x^2) + (5x^3 - 8x) = x^3 - 3x^2 + 5x^3 - 8x = x^3 + 5x^3 - 3x^2 - 8x = 6x^3 - 3x^2 - 8x$ | | | |

SECTION 0.4

22. $(2x^4 - 5x^3) + (7x^3 - x^4 + 2x) = 2x^4 - 5x^3 + 7x^3 - x^4 + 2x$
 $= 2x^4 - x^4 - 5x^3 + 7x^3 + 2x = x^4 + 2x^3 + 2x$
23. $(y^5 + 2y^3 + 7) - (y^5 - 2y^3 - 7) = y^5 + 2y^3 + 7 - y^5 + 2y^3 + 7$
 $= y^5 - y^5 + 2y^3 + 2y^3 + 7 + 7 = 4y^3 + 14$
24. $(3t^7 - 7t^3 + 3) - (7t^7 - 3t^3 + 7) = 3t^7 - 7t^3 + 3 - 7t^7 + 3t^3 - 7$
 $= 3t^7 - 7t^7 - 7t^3 + 3t^3 + 3 - 7 = -4t^7 - 4t^3 - 4$
25. $2(x^2 + 3x - 1) - 3(x^2 + 2x - 4) + 4 = 2(x^2) + 2(3x) + 2(-1) - 3(x^2) - 3(2x) - 3(-4) + 4$
 $= 2x^2 + 6x - 2 - 3x^2 - 6x + 12 + 4$
 $= 2x^2 - 3x^2 + 6x - 6x - 2 + 12 + 4 = -x^2 + 14$
26. $5(x^3 - 8x + 3) + 2(3x^2 + 5x) - 7 = 5(x^3) + 5(-8x) + 5(3) + 2(3x^2) + 2(5x) - 7$
 $= 5x^3 - 40x + 15 + 6x^2 + 10x - 7$
 $= 5x^3 + 6x^2 - 40x + 10x + 15 - 7 = 5x^3 + 6x^2 - 30x + 8$
27. $8(t^2 - 2t + 5) + 4(t^2 - 3t + 2) - 6(2t^2 - 8)$
 $= 8(t^2) + 8(-2t) + 8(5) + 4(t^2) + 4(-3t) + 4(2) - 6(2t^2) - 6(-8)$
 $= 8t^2 - 16t + 40 + 4t^2 - 12t + 8 - 12t^2 + 48$
 $= 8t^2 + 4t^2 - 12t^2 - 16t - 12t + 40 + 8 + 48 = -28t + 96$
28. $-3(x^3 - x) + 2(x^2 + x) + 3(x^3 - 2x) = -3(x^3) - 3(-x) + 2(x^2) + 2(x) + 3(x^3) + 3(-2x)$
 $= -3x^3 + 3x + 2x^2 + 2x + 3x^3 - 6x$
 $= -3x^3 + 3x^3 + 2x^2 + 3x + 2x - 6x = 2x^2 - x$
29. $y(y^2 - 1) - y^2(y + 2) - y(2y - 2) = y(y^2) + y(-1) - y^2(y) - y^2(2) - y(2y) - y(-2)$
 $= y^3 - y - y^3 - 2y^2 - 2y^2 + 2y$
 $= y^3 - y^3 - 2y^2 - 2y^2 - y + 2y = -4y^2 + y$
30. $-4a^2(a + 1) + 3a(a^2 - 4) - a^2(a + 2)$
 $= -4a^2(a) - 4a^2(1) + 3a(a^2) + 3a(-4) - a^2(a) - a^2(2)$
 $= -4a^3 - 4a^2 + 3a^3 - 12a - a^3 - 2a^2$
 $= -4a^3 + 3a^3 - a^3 - 4a^2 - 2a^2 - 12a = -2a^3 - 6a^2 - 12a$
31. $xy(x - 4y) - y(x^2 + 3xy) + xy(2x + 3y)$
 $= xy(x) + xy(-4y) - y(x^2) - y(3xy) + xy(2x) + xy(3y)$
 $= x^2y - 4xy^2 - x^2y - 3xy^2 + 2x^2y + 3xy^2$
 $= x^2y - x^2y + 2x^2y - 4xy^2 - 3xy^2 + 3xy^2 = 2x^2y - 4xy^2$

SECTION 0.4

- 32.** $3mn(m + 2n) - 6m(3mn + 1) - 2n(4mn - 1)$
 $= 3mn(m) + 3mn(2n) - 6m(3mn) - 6m(1) - 2n(4mn) - 2n(-1)$
 $= 3m^2n + 6mn^2 - 18m^2n - 6m - 8mn^2 + 2n$
 $= 3m^2n - 18m^2n + 6mn^2 - 8mn^2 - 6m + 2n = -15m^2n - 2mn^2 - 6m + 2n$
- 33.** $2x^2y^3(4xy^4) = 2(4)x^2xy^3y^4 = 8x^3y^7$ **34.** $-15a^3b(-2a^2b^3) = -15(-2)a^3a^2bb^3$
 $= 30a^5b^4$
- 35.** $-3m^2n(2mn^2)\left(-\frac{mn}{12}\right) = (-3)(2)\left(-\frac{1}{12}\right)m^2mmnn^2n = \frac{6}{12}m^4n^4 = \frac{m^4n^4}{2}$
- 36.** $-\frac{3r^2s^3}{5}\left(\frac{2r^2s}{3}\right)\left(\frac{15rs^2}{2}\right) = \left(-\frac{3}{5}\right)\left(\frac{2}{3}\right)\left(\frac{15}{2}\right)r^2r^2rs^3ss^2 = -3r^5s^6$
- 37.** $-4rs(r^2 + s^2) = -4rs(r^2) - 4rs(s^2) = -4r^3s - 4rs^3$
- 38.** $6u^2v(2uv^2 - y) = 6u^2v(2uv^2) + 6u^2v(-y) = 12u^3v^3 - 6u^2vy$
- 39.** $6ab^2c(2ac + 3bc^2 - 4ab^2c) = 6ab^2c(2ac) + 6ab^2c(3bc^2) + 6ab^2c(-4ab^2c)$
 $= 12a^2b^2c^2 + 18ab^3c^3 - 24a^2b^4c^2$
- 40.** $-\frac{mn^2}{2}(4mn - 6m^2 - 8) = -\frac{mn^2}{2}(4mn) - \frac{mn^2}{2}(-6m^2) - \frac{mn^2}{2}(-8)$
 $= -2m^2n^3 + 3m^3n^2 + 4mn^2$
- 41.** $(a + 2)(a + 2) = a^2 + 2a + 2a + 4$ **42.** $(y - 5)(y - 5) = y^2 - 5y - 5y + 25$
 $= a^2 + 4a + 4$ $= y^2 - 10y + 25$
- 43.** $(a - 6)^2 = (a - 6)(a - 6)$ **44.** $(t + 9)^2 = (t + 9)(t + 9)$
 $= a^2 - 6a - 6a + 36$ $= t^2 + 9t + 9t + 81$
 $= a^2 - 12a + 36$ $= t^2 + 18t + 81$
- 45.** $(x + 4)(x - 4) = x^2 - 4x + 4x - 16$ **46.** $(z + 7)(z - 7) = z^2 - 7z + 7z - 49$
 $= x^2 - 16$ $= z^2 - 49$
- 47.** $(x - 3)(x + 5) = x^2 + 5x - 3x - 15$ **48.** $(z + 4)(z - 6) = z^2 - 6z + 4z - 24$
 $= x^2 + 2x - 15$ $= z^2 - 2z - 24$
- 49.** $(u + 2)(3u - 2) = 3u^2 - 2u + 6u - 4$ **50.** $(4x + 1)(2x - 3) = 8x^2 - 12x + 2x - 3$
 $= 3u^2 + 4u - 4$ $= 8x^2 - 10x - 3$
- 51.** $(5x - 1)(2x + 3) = 10x^2 + 15x - 2x - 3$ **52.** $(4x - 1)(2x - 7) = 8x^2 - 28x - 2x + 7$
 $= 10x^2 + 13x - 3$ $= 8x^2 - 30x + 7$

SECTION 0.4

53. $(3a - 2b)^2 = (3a - 2b)(3a - 2b) = 9a^2 - 6ab - 6ab + 4b^2 = 9a^2 - 12ab + 4b^2$
54. $(4a + 5b)(4a - 5b) = 16a^2 - 20ab + 20ab - 25b^2 = 16a^2 - 25b^2$
55. $(3m + 4n)(3m - 4n) = 9m^2 - 12mn + 12mn - 16n^2 = 9m^2 - 16n^2$
56. $(4r + 3s)^2 = (4r + 3s)(4r + 3s) = 16r^2 + 12rs + 12rs + 9s^2 = 16r^2 + 24rs + 9s^2$
57. $(2y - 4x)(3y - 2x) = 6y^2 - 4xy - 12xy + 8x^2 = 6y^2 - 16xy + 8x^2$
58. $(-2x + 3y)(3x + y) = -6x^2 - 2xy + 9xy + 3y^2 = -6x^2 + 7xy + 3y^2$
59. $(9x - y)(x^2 - 3y) = 9x^3 - 27xy - x^2y + 3y^2 = 9x^3 - x^2y - 27xy + 3y^2$
60. $(8a^2 + b)(a + 2b) = 8a^3 + 16a^2b + ab + 2b^2$
61. $(5z + 2t)(z^2 - t) = 5z^3 - 5tz + 2tz^2 - 2t^2 = 5z^3 + 2tz^2 - 5tz - 2t^2$
62. $(y - 2x^2)(x^2 + 3y) = x^2y + 3y^2 - 2x^4 - 6x^2y = -2x^4 - 5x^2y + 3y^2$
63. $(\sqrt{5} + 3x)(2 - \sqrt{5}x) = 2\sqrt{5} - 5x + 6x - 3\sqrt{5}x^2 = -3\sqrt{5}x^2 + x + 2\sqrt{5}$
64. $(\sqrt{2} + x)(3 + \sqrt{2}x) = 3\sqrt{2} + 2x + 3x + \sqrt{2}x^2 = \sqrt{2}x^2 + 5x + 3\sqrt{2}$
65. $(3x - 1)^3 = (3x - 1)(3x - 1)(3x - 1)$
 $= (9x^2 - 3x - 3x + 1)(3x - 1)$
 $= (9x^2 - 6x + 1)(3x - 1)$
 $= 9x^2(3x) + 9x^2(-1) - 6x(3x) - 6x(-1) + 1(3x) + 1(-1)$
 $= 27x^3 - 9x^2 - 18x^2 + 6x + 3x - 1 = 27x^3 - 27x^2 + 9x - 1$
66. $(2x - 3)^3 = (2x - 3)(2x - 3)(2x - 3)$
 $= (4x^2 - 6x - 6x + 9)(2x - 3)$
 $= (4x^2 - 12x + 9)(2x - 3)$
 $= 4x^2(2x) + 4x^2(-3) - 12x(2x) - 12x(-3) + 9(2x) + 9(-3)$
 $= 8x^3 - 12x^2 - 24x^2 + 36x + 18x - 27 = 8x^3 - 36x^2 + 54x - 27$
67. $(3x + 1)(2x^2 + 4x - 3) = 3x(2x^2) + 3x(4x) + 3x(-3) + 1(2x^2) + 1(4x) + 1(-3)$
 $= 6x^3 + 12x^2 - 9x + 2x^2 + 4x - 3 = 6x^3 + 14x^2 - 5x - 3$
68. $(2x - 5)(x^2 - 3x + 2) = 2x(x^2) + 2x(-3x) + 2x(2) - 5(x^2) - 5(-3x) - 5(2)$
 $= 2x^3 - 6x^2 + 4x - 5x^2 + 15x - 10 = 2x^3 - 11x^2 + 19x - 10$

SECTION 0.4

69. $(3x + 2y)(2x^2 - 3xy + 4y^2)$
 $= 3x(2x^2) + 3x(-3xy) + 3x(4y^2) + 2y(2x^2) + 2y(-3xy) + 2y(4y^2)$
 $= 6x^3 - 9x^2y + 12xy^2 + 4x^2y - 6xy^2 + 8y^3 = 6x^3 - 5x^2y + 6xy^2 + 8y^3$
70. $(4r - 3s)(2r^2 + 4rs - 2s^2)$
 $= 4r(2r^2) + 4r(4rs) + 4r(-2s^2) - 3s(2r^2) - 3s(4rs) - 3s(-2s^2)$
 $= 8r^3 + 16r^2s - 8rs^2 - 6r^2s - 12rs^2 + 6s^3 = 8r^3 + 10r^2s - 20rs^2 + 6s^3$
71. $2y^n(3y^n + y^{-n}) = 2y^n(3y^n) + 2y^n(y^{-n}) = 6y^{n+n} + 2y^{n+(-n)} = 6y^{2n} + 2y^0 = 6y^{2n} + 2$
72. $3a^{-n}(2a^n + 3a^{n-1}) = 3a^{-n}(2a^n) + 3a^{-n}(3a^{n-1}) = 6a^{-n+n} + 9a^{-n+n-1} = 6a^0 + 9a^{-1}$
 $= 6 + \frac{9}{a}$
73. $-5x^{2n}y^n(2x^{2n}y^{-n} + 3x^{-2n}y^n) = -5x^{2n}y^n(2x^{2n}y^{-n}) - 5x^{2n}y^n(3x^{-2n}y^n)$
 $= -10x^{2n+2n}y^{n+(-n)} - 15x^{2n+(-2n)}y^{n+n}$
 $= -10x^{4n}y^0 - 15x^0y^{2n} = -10x^{4n} - 15y^{2n}$
74. $-2a^{3n}b^{2n}(5a^{-3n}b - ab^{-2n}) = -2a^{3n}b^{2n}(5a^{-3n}b) - 2a^{3n}b^{2n}(-ab^{-2n})$
 $= -10a^{3n+(-3n)}b^{2n+1} + 2a^{3n+1}b^{2n+(-2n)}$
 $= -10a^0b^{2n+1} + 2a^{3n+1}b^0 = -10b^{2n+1} + 2a^{3n+1}$
75. $(x^n + 3)(x^n - 4) = x^n x^n - 4x^n + 3x^n - 12 = x^{2n} - x^n - 12$
76. $(a^n - 5)(a^n - 3) = a^n a^n - 3a^n - 5a^n + 15 = a^{2n} - 8a^n + 15$
77. $(2r^n - 7)(3r^n - 2) = 2r^n(3r^n) - 2r^n(2) - 7(3r^n) + 14$
 $= 6r^{2n} - 4r^n - 21r^n + 14 = 6r^{2n} - 25r^n + 14$
78. $(4z^n + 3)(3z^n + 1) = 4z^n(3z^n) + 4z^n(1) + 3(3z^n) + 3$
 $= 12z^{2n} + 4z^n + 9z^n + 3 = 12z^{2n} + 13z^n + 3$
79. $x^{1/2}(x^{1/2}y + xy^{1/2}) = x^{1/2}x^{1/2}y + x^{1/2}xy^{1/2} = x^{2/2}y + x^{3/2}y^{1/2} = xy + x^{3/2}y^{1/2}$
80. $ab^{1/2}(a^{1/2}b^{1/2} + b^{1/2}) = ab^{1/2}a^{1/2}b^{1/2} + ab^{1/2}b^{1/2} = a^{3/2}b^{2/2} + ab^{2/2} = a^{3/2}b + ab$
81. $(a^{1/2} + b^{1/2})(a^{1/2} - b^{1/2}) = a^{1/2}a^{1/2} - a^{1/2}b^{1/2} + a^{1/2}b^{1/2} - b^{1/2}b^{1/2}$
 $= a^{2/2} - b^{2/2} = a - b$
82. $(x^{3/2} + y^{1/2})^2 = (x^{3/2} + y^{1/2})(x^{3/2} + y^{1/2}) = x^{3/2}x^{3/2} + x^{3/2}y^{1/2} + x^{3/2}y^{1/2} + y^{1/2}y^{1/2}$
 $= x^{6/2} + 2x^{3/2}y^{1/2} + y^{2/2}$
 $= x^3 + 2x^{3/2}y^{1/2} + y$

SECTION 0.4

$$83. \frac{2}{\sqrt{3}-1} = \frac{2}{\sqrt{3}-1} \cdot \frac{\sqrt{3}+1}{\sqrt{3}+1} = \frac{2(\sqrt{3}+1)}{(\sqrt{3})^2-1^2} = \frac{2(\sqrt{3}+1)}{3-1} = \frac{2(\sqrt{3}+1)}{2} = \sqrt{3}+1$$

$$84. \frac{1}{\sqrt{5}+2} = \frac{1}{\sqrt{5}+2} \cdot \frac{\sqrt{5}-2}{\sqrt{5}-2} = \frac{1(\sqrt{5}-2)}{(\sqrt{5})^2-2^2} = \frac{\sqrt{5}-2}{5-4} = \frac{\sqrt{5}-2}{1} = \sqrt{5}-2$$

$$85. \frac{3x}{\sqrt{7}+2} = \frac{3x}{\sqrt{7}+2} \cdot \frac{\sqrt{7}-2}{\sqrt{7}-2} = \frac{3x(\sqrt{7}-2)}{(\sqrt{7})^2-2^2} = \frac{3x(\sqrt{7}-2)}{7-4} = \frac{3x(\sqrt{7}-2)}{3} = x(\sqrt{7}-2)$$

$$86. \frac{14y}{\sqrt{2}-3} = \frac{14y}{\sqrt{2}-3} \cdot \frac{\sqrt{2}+3}{\sqrt{2}+3} = \frac{14y(\sqrt{2}+3)}{(\sqrt{2})^2-3^2} = \frac{14y(\sqrt{2}+3)}{2-9} = -2y(\sqrt{2}+3)$$

$$87. \frac{x}{x-\sqrt{3}} = \frac{x}{x-\sqrt{3}} \cdot \frac{x+\sqrt{3}}{x+\sqrt{3}} = \frac{x(x+\sqrt{3})}{x^2-(\sqrt{3})^2} = \frac{x(x+\sqrt{3})}{x^2-3}$$

$$88. \frac{y}{2y+\sqrt{7}} = \frac{y}{2y+\sqrt{7}} \cdot \frac{2y-\sqrt{7}}{2y-\sqrt{7}} = \frac{y(2y-\sqrt{7})}{(2y)^2-(\sqrt{7})^2} = \frac{y(2y-\sqrt{7})}{4y^2-7}$$

$$89. \frac{y+\sqrt{2}}{y-\sqrt{2}} = \frac{y+\sqrt{2}}{y-\sqrt{2}} \cdot \frac{y+\sqrt{2}}{y+\sqrt{2}} = \frac{(y+\sqrt{2})(y+\sqrt{2})}{y^2-(\sqrt{2})^2} = \frac{y^2+2y\sqrt{2}+2}{y^2-2}$$

$$90. \frac{x-\sqrt{3}}{x+\sqrt{3}} = \frac{x-\sqrt{3}}{x+\sqrt{3}} \cdot \frac{x-\sqrt{3}}{x-\sqrt{3}} = \frac{(x-\sqrt{3})(x-\sqrt{3})}{x^2-(\sqrt{3})^2} = \frac{x^2-2x\sqrt{3}+3}{x^2-3}$$

$$91. \frac{\sqrt{2}-\sqrt{3}}{1-\sqrt{3}} = \frac{\sqrt{2}-\sqrt{3}}{1-\sqrt{3}} \cdot \frac{1+\sqrt{3}}{1+\sqrt{3}} = \frac{\sqrt{2}+\sqrt{6}-\sqrt{3}-\left(\sqrt{3}\right)^2}{1^2-\left(\sqrt{3}\right)^2} = \frac{\sqrt{2}+\sqrt{6}-\sqrt{3}-3}{1-3}$$

$$= \frac{\sqrt{2}+\sqrt{6}-\sqrt{3}-3}{-2}$$

$$= \frac{-\left(\sqrt{2}+\sqrt{6}-\sqrt{3}-3\right)}{2}$$

$$= \frac{\sqrt{3}+3-\sqrt{2}-\sqrt{6}}{2}$$

SECTION 0.4

$$\begin{aligned}
 92. \quad \frac{\sqrt{3}-\sqrt{2}}{1+\sqrt{2}} &= \frac{\sqrt{3}-\sqrt{2}}{1+\sqrt{2}} \cdot \frac{1-\sqrt{2}}{1-\sqrt{2}} = \frac{\sqrt{3}-\sqrt{6}-\sqrt{2}+(\sqrt{2})^2}{1^2-(\sqrt{2})^2} = \frac{\sqrt{3}-\sqrt{6}-\sqrt{2}+2}{1-2} \\
 &= \frac{\sqrt{3}-\sqrt{6}-\sqrt{2}+2}{-1} \\
 &= -(\sqrt{3}-\sqrt{6}-\sqrt{2}+2) \\
 &= \sqrt{6}+\sqrt{2}-\sqrt{3}-2
 \end{aligned}$$

$$93. \quad \frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}+\sqrt{y}} = \frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}+\sqrt{y}} \cdot \frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}-\sqrt{y}} = \frac{\sqrt{x^2}-\sqrt{xy}-\sqrt{xy}+\sqrt{y^2}}{(\sqrt{x})^2-(\sqrt{y})^2} = \frac{x-2\sqrt{xy}+y}{x-y}$$

$$94. \quad \frac{\sqrt{2x}+y}{\sqrt{2x}-y} = \frac{\sqrt{2x}+y}{\sqrt{2x}-y} \cdot \frac{\sqrt{2x}+y}{\sqrt{2x}+y} = \frac{\sqrt{4x^2}+y\sqrt{2x}+y\sqrt{2x}+y^2}{(\sqrt{2x})^2-y^2} = \frac{2x+2y\sqrt{2x}+y^2}{2x-y^2}$$

$$95. \quad \frac{\sqrt{2}+1}{2} = \frac{\sqrt{2}+1}{2} \cdot \frac{\sqrt{2}-1}{\sqrt{2}-1} = \frac{(\sqrt{2})^2-1^2}{2(\sqrt{2}-1)} = \frac{2-1}{2(\sqrt{2}-1)} = \frac{1}{2(\sqrt{2}-1)}$$

$$96. \quad \frac{\sqrt{x}-3}{3} = \frac{\sqrt{x}-3}{3} \cdot \frac{\sqrt{x}+3}{\sqrt{x}+3} = \frac{(\sqrt{x})^2-3^2}{3(\sqrt{x}+3)} = \frac{x-9}{3(\sqrt{x}+3)}$$

$$97. \quad \frac{y-\sqrt{3}}{y+\sqrt{3}} = \frac{y-\sqrt{3}}{y+\sqrt{3}} \cdot \frac{y+\sqrt{3}}{y+\sqrt{3}} = \frac{y^2-(\sqrt{3})^2}{y^2+y\sqrt{3}+y\sqrt{3}+\sqrt{9}} = \frac{y^2-3}{y^2+2y\sqrt{3}+3}$$

$$98. \quad \frac{\sqrt{a}-\sqrt{b}}{\sqrt{a}+\sqrt{b}} = \frac{\sqrt{a}-\sqrt{b}}{\sqrt{a}+\sqrt{b}} \cdot \frac{\sqrt{a}+\sqrt{b}}{\sqrt{a}+\sqrt{b}} = \frac{(\sqrt{a})^2-(\sqrt{b})^2}{\sqrt{a^2}+\sqrt{ab}+\sqrt{ab}+\sqrt{b^2}} = \frac{a-b}{a+2\sqrt{ab}+b}$$

$$\begin{aligned}
 99. \quad \frac{\sqrt{x+3}-\sqrt{x}}{3} &= \frac{\sqrt{x+3}-\sqrt{x}}{3} \cdot \frac{\sqrt{x+3}+\sqrt{x}}{\sqrt{x+3}+\sqrt{x}} = \frac{(\sqrt{x+3})^2-(\sqrt{x})^2}{3(\sqrt{x+3}+\sqrt{x})} \\
 &= \frac{x+3-x}{3(\sqrt{x+3}+\sqrt{x})} \\
 &= \frac{3}{3(\sqrt{x+3}+\sqrt{x})} = \frac{1}{\sqrt{x+3}+\sqrt{x}}
 \end{aligned}$$

SECTION 0.4

$$\begin{aligned}
 100. \quad \frac{\sqrt{2+h}-\sqrt{2}}{h} &= \frac{\sqrt{2+h}-\sqrt{2}}{h} \cdot \frac{\sqrt{2+h}+\sqrt{2}}{\sqrt{2+h}+\sqrt{2}} = \frac{(\sqrt{2+h})^2 - (\sqrt{2})^2}{h(\sqrt{2+h}+\sqrt{2})} \\
 &= \frac{2+h-2}{h(\sqrt{2+h}+\sqrt{2})} \\
 &= \frac{h}{h(\sqrt{2+h}+\sqrt{2})} = \frac{1}{\sqrt{2+h}+\sqrt{2}}
 \end{aligned}$$

$$101. \quad \frac{36a^2b^3}{18ab^6} = 2a^{2-1}b^{3-6} = 2a^1b^{-3} = \frac{2a}{b^3}$$

$$102. \quad \frac{-45r^2s^5t^3}{27r^6s^2t^8} = -\frac{5}{3}r^{2-6}s^{5-2}t^{3-8} = -\frac{5}{3}r^{-4}s^3t^{-5} = -\frac{5s^3}{3r^4t^5}$$

$$103. \quad \frac{16x^6y^4z^9}{-24x^9y^6z^0} = -\frac{2}{3}x^{6-9}y^{4-6}z^{9-0} = -\frac{2}{3}x^{-3}y^{-2}z^9 = -\frac{2z^9}{3x^3y^2}$$

$$104. \quad \frac{32m^6n^4p^2}{26m^6n^7p^2} = \frac{16}{13}m^{6-6}n^{4-7}p^{2-2} = \frac{16}{13}m^0n^{-3}p^0 = \frac{16}{13n^3}$$

$$\begin{aligned}
 105. \quad \frac{5x^3y^2 + 15x^3y^4}{10x^2y^3} &= \frac{5x^3y^2}{10x^2y^3} + \frac{15x^3y^4}{10x^2y^3} \\
 &= \frac{x}{2y} + \frac{3xy}{2}
 \end{aligned}$$

$$\begin{aligned}
 106. \quad \frac{9m^4n^9 - 6m^3n^4}{12m^3n^3} &= \frac{9m^4n^9}{12m^3n^3} - \frac{6m^3n^4}{12m^3n^3} \\
 &= \frac{3mn^6}{4} - \frac{n}{2}
 \end{aligned}$$

$$107. \quad \frac{24x^5y^7 - 36x^2y^5 + 12xy}{60x^5y^4} = \frac{24x^5y^7}{60x^5y^4} - \frac{36x^2y^5}{60x^5y^4} + \frac{12xy}{60x^5y^4} = \frac{2y^3}{5} - \frac{3y}{5x^3} + \frac{1}{5x^4y^3}$$

$$108. \quad \frac{9a^3b^4 + 27a^2b^4 - 18a^2b^3}{18a^2b^7} = \frac{9a^3b^4}{18a^2b^7} + \frac{27a^2b^4}{18a^2b^7} - \frac{18a^2b^3}{18a^2b^7} = \frac{a}{2b^3} + \frac{3}{2b^3} - \frac{1}{b^4}$$

$$\begin{array}{r}
 109. \quad x + 3 \sqrt{\begin{array}{r} 3x + 2 \\ 3x^2 + 11x + 6 \\ \hline 3x^2 + 9x \\ \hline 2x + 6 \\ \hline 2x + 6 \\ \hline 0 \end{array}}
 \end{array}$$

$$\begin{array}{r}
 110. \quad 3x + 2 \sqrt{\begin{array}{r} x + 3 \\ 3x^2 + 11x + 6 \\ \hline 3x^2 + 2x \\ \hline 9x + 6 \\ \hline 9x + 6 \\ \hline 0 \end{array}}
 \end{array}$$

$$\begin{array}{r}
 111. \quad 2x - 5 \sqrt{\begin{array}{r} x - 7 + \frac{2}{2x-5} \\ 2x^2 - 19x + 37 \\ \hline 2x^2 - 5x \\ \hline -14x + 37 \\ \hline -14x + 35 \\ \hline 2 \end{array}}
 \end{array}$$

$$\begin{array}{r}
 112. \quad x - 7 \sqrt{\begin{array}{r} 2x - 5 \\ 2x^2 - 19x + 35 \\ \hline 2x^2 - 14x \\ \hline -5x + 35 \\ \hline -5x + 35 \\ \hline 0 \end{array}}
 \end{array}$$

SECTION 0.4

$$113. \quad x - 1 \overline{\begin{array}{r} 2x^2 + 2x + 2 + \frac{3}{x-1} \\ 2x^3 + 0x^2 + 0x + 1 \\ \underline{2x^3 - 2x^2} \\ 2x^2 + 0x + 1 \\ \underline{2x^2 - 2x} \\ 2x + 1 \\ \underline{2x - 2} \\ 3 \end{array}}$$

$$114. \quad 2x - 7 \overline{\begin{array}{r} x^2 - x + 3 + \frac{1}{2x-7} \\ 2x^3 - 9x^2 + 13x - 20 \\ \underline{2x^3 - 7x^2} \\ -2x^2 + 13x - 20 \\ \underline{-2x^2 + 7x} \\ 6x - 20 \\ \underline{6x - 21} \\ 1 \end{array}}$$

$$115. \quad x^2 + x - 1 \overline{\begin{array}{r} x - 3 \\ x^3 - 2x^2 - 4x + 3 \\ \underline{x^3 + x^2 - x} \\ -3x^2 - 3x + 3 \\ \underline{-3x^2 - 3x + 3} \\ 0 \end{array}}$$

$$116. \quad x^2 - 3 \overline{\begin{array}{r} x - 2 + \frac{-x-1}{x^2-3} \\ x^3 - 2x^2 - 4x + 5 \\ \underline{x^3 - 3x} \\ -2x^2 - x + 5 \\ \underline{-2x^2 + 6} \\ -x - 1 \end{array}}$$

$$117. \quad x^3 - 2 \overline{\begin{array}{r} x^2 - 2 + \frac{-x^2+5}{x^3-2} \\ x^5 + 0x^4 - 2x^3 - 3x^2 + 0x + 9 \\ \underline{x^5 - 2x^2} \\ -2x^3 - x^2 + 0x + 9 \\ \underline{-2x^3 + 4} \\ -x^2 + 5 \end{array}}$$

$$118. \quad x^3 - 3 \overline{\begin{array}{r} x^2 - 2 + \frac{3}{x^3-3} \\ x^5 + 0x^4 - 2x^3 - 3x^2 + 0x + 9 \\ \underline{x^5 - 3x^2} \\ -2x^3 + 0x + 9 \\ \underline{-2x^3 + 6} \\ 3 \end{array}}$$

$$119. \quad x - 2 \overline{\begin{array}{r} x^4 + 2x^3 + 4x^2 + 8x + 16 \\ x^5 + 0x^4 + 0x^3 + 0x^2 + 0x - 32 \\ \underline{x^5 - 2x^4} \\ 2x^4 + 0x^3 \\ \underline{2x^4 - 4x^3} \\ 4x^3 + 0x^2 \\ \underline{4x^3 - 8x^2} \\ 8x^2 + 0x \\ \underline{8x^2 - 16x} \\ 16x - 32 \\ \underline{16x - 32} \\ 0 \end{array}}$$

$$120. \quad x + 1 \overline{\begin{array}{r} x^3 - x^2 + x - 1 \\ x^4 + 0x^3 + 0x^2 + 0x - 1 \\ \underline{x^4 + x^3} \\ -x^3 + 0x^2 \\ \underline{-x^3 - x^2} \\ x^2 + 0x \\ \underline{x^2 + x} \\ -x - 1 \\ \underline{-x - 1} \\ 0 \end{array}}$$

$$121. \quad 6x^2 + 11x - 10 \overline{\begin{array}{r} 6x^2 + x - 12 \\ 36x^4 + 72x^3 - 121x^2 - 142x + 120 \\ \underline{36x^4 + 66x^3 - 60x^2} \\ 6x^3 - 61x^2 - 142x \\ \underline{6x^3 + 11x^2 - 10x} \\ -72x^2 - 132x + 120 \\ \underline{-72x^2 - 132x + 120} \\ 0 \end{array}}$$

SECTION 0.4

$$\begin{array}{r}
 122. \quad 6x^2 + x - 12 \left| \begin{array}{r} 6x^2 + 11x - 10 \\ 36x^4 + 72x^3 - 121x^2 - 142x + 120 \end{array} \right. \\
 \underline{36x^4 + 6x^3 - 72x^2} \\
 66x^3 - 49x^2 - 142x \\
 \underline{66x^3 + 11x^2 - 132x} \\
 -60x^2 - 10x + 120 \\
 \underline{-60x^2 - 10x + 120} \\
 0
 \end{array}$$

123. Area = length · width = $(x + 5)(x - 2)$ ft² = $(x^2 - 2x + 5x - 10)$ ft² = $(x^2 + 3x - 10)$ ft²

$$\begin{array}{r}
 124. \quad \text{Area} = \frac{1}{2} \cdot \text{base} \cdot \text{height} \\
 x^2 + 3x - 40 = \frac{1}{2}(x + 8) \cdot \text{height} \\
 2(x^2 + 3x - 40) = (x + 8) \cdot \text{height} \\
 2x^2 + 6x - 80 = (x + 8) \cdot \text{height} \\
 \frac{2x^2 + 6x - 80}{x + 8} = \text{height}
 \end{array}
 \quad
 \begin{array}{r}
 x + 8 \left| \begin{array}{r} 2x - 10 \\ 2x^2 + 6x - 80 \end{array} \right. \\
 \underline{2x^2 + 16x} \\
 -10x - 80 \\
 \underline{-10x - 80} \\
 0
 \end{array}$$

The height is $(2x - 10)$ ft.

125. Volume = $l \cdot w \cdot h$

$$\begin{aligned}
 &= (12 - 2x)(12 - 2x)x \text{ in.}^3 \\
 &= (144 - 48x + 4x^2)x \text{ in.}^3 \\
 &= (144x - 48x^2 + 4x^3) \text{ in.}^3
 \end{aligned}$$

126. $t = \frac{d}{r} = \frac{3x^2 + 19x + 20}{3x + 4}$

$$\begin{array}{r}
 3x + 4 \left| \begin{array}{r} x + 5 \\ 3x^2 + 19x + 20 \end{array} \right. \\
 \underline{3x^2 + 4x} \\
 15x + 20 \\
 \underline{15x + 20} \\
 0
 \end{array}$$

$t = x + 5$

127. $(a + b + c)^2 = (a + b + c)(a + b + c) = a(a + b + c) + b(a + b + c) + c(a + b + c)$

$$\begin{aligned}
 &= a^2 + ab + ac + ab + b^2 + bc + ac + bc + c^2 \\
 &= a^2 + b^2 + c^2 + 2ab + 2bc + 2ac
 \end{aligned}$$

128. $(a + b + c + d)^2 = (a + b + c + d)(a + b + c + d)$

$$\begin{aligned}
 &= a(a + b + c + d) + b(a + b + c + d) + c(a + b + c + d) + d(a + b + c + d) \\
 &= a^2 + ab + ac + ad + ab + b^2 + bc + bd + ac + bc + c^2 + cd + ad + bd + cd + d^2 \\
 &= a^2 + b^2 + c^2 + d^2 + 2ab + 2ac + 2ad + 2bc + 2bd + 2cd
 \end{aligned}$$

129. Answers may vary.

130. Multiply the numerator and denominator by the conjugate of the numerator $(\sqrt{x} - 2)$.

131. Check the formula with $a = 1$ and $b = 2$.

132. Check the formula with $a = 3$ and $b = 4$.

133. $9^{3/2} = (9^{1/2})^3 = 3^3 = 27$

SECTION 0.4

$$134. \left(\frac{8}{125}\right)^{-2/3} = \left(\frac{125}{8}\right)^{2/3} = \left(\left(\frac{125}{8}\right)^{1/3}\right)^2 = \left(\frac{5}{2}\right)^2 = \frac{25}{4}$$

$$135. \left(\frac{625x^4}{16y^8}\right)^{3/4} = \frac{625^{3/4}(x^4)^{3/4}}{16^{3/4}(y^8)^{3/4}} = \frac{125x^3}{8y^6} \qquad 136. \sqrt{80x^4} = \sqrt{16x^4}\sqrt{5} = 4x^2\sqrt{5}$$

$$137. \sqrt[3]{16ab^4} - b\sqrt[3]{54ab} = \sqrt[3]{8b^3}\sqrt[3]{2ab} - b\sqrt[3]{27}\sqrt[3]{2ab} = 2b\sqrt[3]{2ab} - b(3)\sqrt[3]{2ab} = 2b\sqrt[3]{2ab} - 3b\sqrt[3]{2ab} \\ = -b\sqrt[3]{2ab}$$

$$138. x\sqrt[4]{1,280x} + \sqrt[4]{80x^5} = x\sqrt[4]{256}\sqrt[4]{5x} + \sqrt[4]{16x^4}\sqrt[4]{5x} = 4x\sqrt[4]{5x} + 2x\sqrt[4]{5x} = 6x\sqrt[4]{5x}$$

Exercises 0.5 (page 61)

- | | |
|---|---|
| <p>1. factor</p> <p>3. $ax + bx = x(a + b)$</p> <p>5. $x^2 + 2xy + y^2 = (x + y)(x + y) = (x + y)^2$</p> <p>7. $x^3 + y^3 = (x + y)(x^2 - xy + y^2)$</p> <p>9. $3x - 6 = 3(x - 2)$</p> <p>11. $8x^2 + 4x^3 = 4x^2(2 + x)$</p> <p>13. $7x^2y^2 + 14x^3y^2 = 7x^2y^2(1 + 2x)$</p> <p>15. $a(x + y) + b(x + y) = (x + y)(a + b)$</p> <p>17. $4a + b - 12a^2 - 3ab = 4a + b - 3a(4a + b) = 1(4a + b) - 3a(4a + b) = (4a + b)(1 - 3a)$</p> <p>18. $x^2 + 4x + xy + 4y = x(x + 4) + y(x + 4) = (x + 4)(x + y)$</p> <p>19. $4x^2 - 9 = (2x)^2 - 3^2 = (2x + 3)(2x - 3)$</p> <p>21. $4 - 9r^2 = 2^2 - (3r)^2 = (2 + 3r)(2 - 3r)$</p> <p>23. $81x^4 - 1 = (9x^2)^2 - 1^2 = (9x^2 + 1)(9x^2 - 1) = (9x^2 + 1)(3x + 1)(3x - 1)$</p> <p>24. $81 - x^4 = 9^2 - (x^2)^2 = (9 + x^2)(9 - x^2) = (9 + x^2)(3 + x)(3 - x)$</p> <p>25. $(x + z)^2 - 25 = (x + z)^2 - 5^2 \\ = (x + z + 5)(x + z - 5)$</p> | <p>2. integer, prime</p> <p>4. $x^2 - y^2 = (x + y)(x - y)$</p> <p>6. $x^2 - 2xy + y^2 = (x - y)(x - y) = (x - y)^2$</p> <p>8. $x^3 - y^3 = (x - y)(x^2 + xy + y^2)$</p> <p>10. $5y - 15 = 5(y - 3)$</p> <p>12. $9y^3 + 6y^2 = 3y^2(3y + 2)$</p> <p>14. $25y^2z - 15yz^2 = 5yz(5y - 3z)$</p> <p>16. $b(x - y) + a(x - y) = (x - y)(b + a)$</p> <p>20. $36z^2 - 49 = (6z)^2 - 7^2 = (6z + 7)(6z - 7)$</p> <p>22. $16 - 49x^2 = 4^2 - (7x)^2 = (4 + 7x)(4 - 7x)$</p> <p>26. $(x - y)^2 - 9 = (x - y)^2 - 3^2 \\ = (x - y + 3)(x - y - 3)$</p> |
|---|---|

SECTION 0.5

27. $x^2 + 8x + 16 = (x + 4)(x + 4) = (x + 4)^2$
28. $a^2 - 12a + 36 = (a - 6)(a - 6) = (a - 6)^2$
29. $b^2 - 10b + 25 = (b - 5)(b - 5) = (b - 5)^2$
30. $y^2 + 14y + 49 = (y + 7)(y + 7) = (y + 7)^2$
31. $m^2 + 4mn + 4n^2 = (m + 2n)(m + 2n)$
 $= (m + 2n)^2$
32. $r^2 - 8rs + 16s^2 = (r - 4s)(r - 4s)$
 $= (r - 4s)^2$
33. $12x^2 - xy - 6y^2 = (4x - 3y)(3x + 2y)$
34. $8x^2 - 10xy - 3y^2 = (4x + y)(2x - 3y)$
35. $x^2 + 10x + 21$: $a = 1, b = 10, c = 21$
 key number = $ac = 1(21) = 21$
 $x^2 + 10x + 21 = x^2 + 7x + 3x + 21$
 $= x(x + 7) + 3(x + 7)$
 $= (x + 7)(x + 3)$
36. $x^2 + 7x + 10$: $a = 1, b = 7, c = 10$
 key number = $ac = 1(10) = 10$
 $x^2 + 7x + 10 = x^2 + 5x + 2x + 10$
 $= x(x + 5) + 2(x + 5)$
 $= (x + 5)(x + 2)$
37. $x^2 - 4x - 12$: $a = 1, b = -4, c = -12$
 key number = $ac = 1(-12) = -12$
 $x^2 - 4x - 12 = x^2 - 6x + 2x - 12$
 $= x(x - 6) + 2(x - 6)$
 $= (x - 6)(x + 2)$
38. $x^2 - 2x - 63$: $a = 1, b = -2, c = -63$
 key number = $ac = 1(-63) = -63$
 $x^2 - 2x - 63 = x^2 - 9x + 7x - 63$
 $= x(x - 9) + 7(x - 9)$
 $= (x - 9)(x + 7)$
39. $6p^2 + 7p - 3$: $a = 6, b = 7, c = -3$
 key number = $ac = 6(-3) = -18$
 $6p^2 + 7p - 3 = 6p^2 + 9p - 2p - 3$
 $= 3p(2p + 3) - (2p + 3)$
 $= (2p + 3)(3p - 1)$
40. $4q^2 - 19q + 12$: $a = 4, b = -19, c = 12$
 key number = $ac = 4(12) = 48$
 $4q^2 - 19q + 12 = 4q^2 - 3q - 16q + 12$
 $= q(4q - 3) - 4(4q - 3)$
 $= (4q - 3)(q - 4)$
41. $t^3 + 343 = t^3 + 7^3 = (t + 7)[t^2 - (t)(7) + 7^2] = (t + 7)(t^2 - 7t + 49)$
42. $r^3 + 8s^3 = r^3 + (2s)^3 = (r + 2s)[r^2 - (r)(2s) + (2s)^2] = (r + 2s)(r^2 - 2rs + 4s^2)$
43. $8z^3 - 27 = (2z)^3 - 3^3 = (2z - 3)[(2z)^2 + (2z)(3) + 3^2] = (2z - 3)(4z^2 + 6z + 9)$
44. $125a^3 - 64 = (5a)^3 - 4^3 = (5a - 4)[(5a)^2 + (5a)(4) + 4^2] = (5a - 4)(25a^2 + 20a + 16)$
45. $3a^2bc + 6ab^2c + 9abc^2 = 3abc(a + 2b + 3c)$
46. $5x^3y^3z^3 + 25x^2y^2z^2 - 125xyz = 5xyz(x^2y^2z^2 + 5xyz - 25)$
47. $3x^3 + 3x^2 - x - 1 = 3x^2(x + 1) - 1(x + 1) = (x + 1)(3x^2 - 1)$
48. $4x + 6xy - 9y - 6 = 2x(2 + 3y) - 3(3y + 2) = (3y + 2)(2x - 3)$
49. $2txy + 2ctx - 3ty - 3ct = t(2xy + 2cx - 3y - 3c) = t[2x(y + c) - 3(y + c)] = t(y + c)(2x - 3)$

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75. $6x^4 - 11x^3 - 35x^2 = x^2(6x^2 - 11x - 35) = x^2(2x - 7)(3x + 5)$
76. $12x + 17x^2 - 7x^3 = -7x^3 + 17x^2 + 12x = -x(7x^2 - 17x - 12) = -x(x - 3)(7x + 4)$
77. $x^4 + 2x^2 - 15 = (x^2 + 5)(x^2 - 3)$
78. $x^4 - x^2 - 6 = (x^2 - 3)(x^2 + 2)$
79. $a^{2n} - 2a^n - 3 = (a^n - 3)(a^n + 1)$
80. $a^{2n} + 6a^n + 8 = (a^n + 4)(a^n + 2)$
81. $6x^{2n} - 7x^n + 2 = (3x^n - 2)(2x^n - 1)$
82. $9x^{2n} + 9x^n + 2 = (3x^n + 2)(3x^n + 1)$
83. $4x^{2n} - 9y^{2n} = (2x^n)^2 - (3y^n)^2$
 $= (2x^n + 3y^n)(2x^n - 3y^n)$
84. $8x^{2n} - 2x^n - 3 = (4x^n - 3)(2x^n + 1)$
85. $10y^{2n} - 11y^n - 6 = (5y^n + 2)(2y^n - 3)$
86. $16y^{4n} - 25y^{2n} = y^{2n}(16y^{2n} - 25)$
 $= y^{2n}[(4y^n)^2 - 5^2]$
 $= y^{2n}(4y^n + 5)(4y^n - 5)$
87. $2x^3 + 2,000 = 2(x^3 + 1,000) = 2(x^3 + 10^3) = 2(x + 10)(x^2 - 10x + 100)$
88. $3y^3 + 648 = 3(y^3 + 216) = 3(y^3 + 6^3) = 3(y + 6)(y^2 - 6y + 36)$
89. $(x + y)^3 - 64 = (x + y)^3 - 4^3 = [(x + y) - 4][(x + y)^2 + 4(x + y) + 4^2]$
 $= (x + y - 4)(x^2 + 2xy + y^2 + 4x + 4y + 16)$
90. $(x - y)^3 + 27 = (x - y)^3 + 3^3 = [(x - y) + 3][(x - y)^2 - 3(x - y) + 3^2]$
 $= (x - y + 3)(x^2 - 2xy + y^2 - 3x + 3y + 9)$
91. $64a^6 - y^6 = (8a^3)^2 - (y^3)^2 = (8a^3 + y^3)(8a^3 - y^3)$
 $= (2a + y)(4a^2 - 2ay + y^2)(2a - y)(4a^2 + 2ay + y^2)$
 $= (2a + y)(2a - y)(4a^2 - 2ay + y^2)(4a^2 + 2ay + y^2)$
92. $a^6 + b^6 = (a^2)^3 + (b^2)^3 = (a^2 + b^2)((a^2)^2 - a^2b^2 + (b^2)^2) = (a^2 + b^2)(a^4 - a^2b^2 + b^4)$
93. $a^3 - b^3 + a - b = (a - b)(a^2 + ab + b^2) + (a - b)1 = (a - b)(a^2 + ab + b^2 + 1)$
94. $(a^2 - y^2) - 5(a + y) = (a + y)(a - y) - 5(a + y) = (a + y)(a - y - 5)$
95. $64x^6 + y^6 = (4x^2)^3 + (y^2)^3 = (4x^2 + y^2)((4x^2)^2 - 4x^2y^2 + (y^2)^2)$
 $= (4x^2 + y^2)(16x^4 - 4x^2y^2 + y^4)$
96. $z^2 + 6z + 9 - 225y^2 = (z + 3)(z + 3) - 225y^2 = (z + 3)^2 - (15y)^2$
 $= (z + 3 + 15y)(z + 3 - 15y)$

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97. $x^2 - 6x + 9 - 144y^2 = (x - 3)(x - 3) - 144y^2 = (x - 3)^2 - (12y)^2$
 $= (x - 3 + 12y)(x - 3 - 12y)$
98. $x^2 + 2x - 9y^2 + 1 = x^2 + 2x + 1 - 9y^2 = (x + 1)(x + 1) - 9y^2$
 $= (x + 1)^2 - (3y)^2 = (x + 1 + 3y)(x + 1 - 3y)$
99. $(a + b)^2 - 3(a + b) - 10 = [(a + b) - 5][(a + b) + 2] = (a + b - 5)(a + b + 2)$
100. $2(a + b)^2 - 5(a + b) - 3 = [2(a + b) + 1][(a + b) - 3] = (2a + 2b + 1)(a + b - 3)$
101. $x^6 + 7x^3 - 8 = (x^3 + 8)(x^3 - 1) = (x + 2)(x^2 - 2x + 4)(x - 1)(x^2 + x + 1)$
102. $x^6 - 13x^4 + 36x^2 = x^2(x^4 - 13x^2 + 36) = x^2(x^2 - 9)(x^2 - 4) = x^2(x + 3)(x - 3)(x + 2)(x - 2)$
103. $x^4 + x^2 + 1 = x^4 + 2x^2 + 1 - x^2$
 $= (x^2 + 1)(x^2 + 1) - x^2$
 $= (x^2 + 1)^2 - x^2$
 $= (x^2 + 1 + x)(x^2 + 1 - x)$
104. $x^4 + 3x^2 + 4 = x^4 + 4x^2 + 4 - x^2$
 $= (x^2 + 2)(x^2 + 2) - x^2$
 $= (x^2 + 2)^2 - x^2$
 $= (x^2 + 2 + x)(x^2 + 2 - x)$
105. $x^4 + 7x^2 + 16 = x^4 + 8x^2 + 16 - x^2$
 $= (x^2 + 4)(x^2 + 4) - x^2$
 $= (x^2 + 4)^2 - x^2$
 $= (x^2 + 4 + x)(x^2 + 4 - x)$
106. $y^4 + 2y^2 + 9 = y^4 + 6y^2 + 9 - 4y^2$
 $= (y^2 + 3)(y^2 + 3) - 4y^2$
 $= (y^2 + 3)^2 - (2y)^2$
 $= (y^2 + 3 + 2y)(y^2 + 3 - 2y)$
107. $4a^4 + 1 + 3a^2 = 4a^4 + 4a^2 + 1 - a^2 = (2a^2 + 1)(2a^2 + 1) - a^2 = (2a^2 + 1)^2 - a^2$
 $= (2a^2 + 1 + a)(2a^2 + 1 - a)$
108. $x^4 + 25 + 6x^2 = x^4 + 10x^2 + 25 - 4x^2 = (x^2 + 5)(x^2 + 5) - 4x^2$
 $= (x^2 + 5)^2 - (2x)^2 = (x^2 + 5 + 2x)(x^2 + 5 - 2x)$
109. $V = \frac{4}{3}\pi r_1^3 - \frac{4}{3}\pi r_2^3$
 $= \frac{4}{3}\pi(r_1^3 - r_2^3)$
 $= \frac{4}{3}\pi(r_1 - r_2)(r_1^2 + r_1r_2 + r_2^2)$
110. $f = 144 - 16t^2$
 $= 16(9 - t^2)$
 $= 16(3 + t)(3 - t)$
- 111-114. Answers may vary.**
115. $3x + 2 = 2\left(\frac{3x}{2} + \frac{2}{2}\right) = 2\left(\frac{3}{2}x + 1\right)$
116. $5x - 3 = 5\left(\frac{5x}{5} - \frac{3}{5}\right) = 5\left(x - \frac{3}{5}\right)$
117. $x^2 + 2x + 4 = 2\left(\frac{x^2}{2} + \frac{2x}{2} + \frac{4}{2}\right)$
 $= 2\left(\frac{1}{2}x^2 + x + 2\right)$
118. $3x^2 - 2x - 5 = 3\left(\frac{3x^2}{3} - \frac{2x}{3} - \frac{5}{3}\right)$
 $= 3\left(x^2 - \frac{2}{3}x - \frac{5}{3}\right)$

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119. $a + b = a\left(\frac{a}{a} + \frac{b}{a}\right) = a\left(1 + \frac{b}{a}\right)$

120. $a - b = b\left(\frac{a}{b} - \frac{b}{b}\right) = b\left(\frac{a}{b} - 1\right)$

121. $x + x^{1/2} = x^{1/2}(x^{1-1/2} + x^{1/2-1/2})$
 $= x^{1/2}(x^{1/2} + 1)$

122. $x^{3/2} - x^{1/2} = x^{1/2}(x^{3/2-1/2} - x^{1/2-1/2})$
 $= x^{1/2}(x - 1)$

123. $2x + \sqrt{2}y = \sqrt{2}\left(\frac{2x}{\sqrt{2}} + \frac{\sqrt{2}y}{\sqrt{2}}\right)$
 $= \sqrt{2}(\sqrt{2}x + y)$

124. $\sqrt{3}a - 3b = \sqrt{3}\left(\frac{\sqrt{3}a}{\sqrt{3}} - \frac{3b}{\sqrt{3}}\right)$
 $= \sqrt{3}(a - \sqrt{3}b)$

125. $ab^{3/2} - a^{3/2}b = ab\left(\frac{ab^{3/2}}{ab} - \frac{a^{3/2}b}{ab}\right)$
 $= ab(b^{1/2} - a^{1/2})$

126. $ab^2 + b = b^{-1}\left(\frac{ab^2}{b^{-1}} + \frac{b}{b^{-1}}\right)$
 $= b^{-1}(ab^3 + b^2)$

127. $x^2 + x - 6 + xy - 2y = (x + 3)(x - 2) + y(x - 2) = (x - 2)(x + 3 + y)$

128. $2x^2 + 5x + 2 - xy - 2y = (2x + 1)(x + 2) - y(x + 2) = (x + 2)(2x + 1 - y)$

129. $a^4 + 2a^3 + a^2 + a + 1 = a^2(a^2 + 2a + 1) + a + 1 = a^2(a + 1)(a + 1) + 1(a + 1)$
 $= (a + 1)[a^2(a + 1) + 1]$
 $= (a + 1)(a^3 + a^2 + 1)$

130. $a^4 + a^3 - 2a^2 + a - 1 = a^2(a^2 + a - 2) + a - 1 = a^2(a + 2)(a - 1) + 1(a - 1)$
 $= (a - 1)[a^2(a + 2) + 1]$
 $= (a - 1)(a^3 + 2a^2 + 1)$

131. The number 1 is neither prime nor composite. 132. $[-2, 3) \Rightarrow \leftarrow \left[\begin{array}{c} \text{---} \\ -2 \quad 3 \end{array} \right] \rightarrow$

133. $(x^3x^2)^4 = (x^5)^4 = x^{20}$

134. $\frac{(a^3)^3(a^2)^4}{(a^2a^3)^3} = \frac{a^9a^8}{(a^5)^3} = \frac{a^{17}}{a^{15}} = a^2$

135. $\left(\frac{3x^4x^3}{6x^{-2}x^4}\right)^0 = 1$

136. $\sqrt{20x^5} = \sqrt{4x^4}\sqrt{5x} = 2x^2\sqrt{5x}$

137. $\sqrt{20x} - \sqrt{125x} = \sqrt{4}\sqrt{5x} - \sqrt{25}\sqrt{5x} = 2\sqrt{5x} - 5\sqrt{5x} = -3\sqrt{5x}$

138. $\frac{3}{\sqrt[3]{3}} = \frac{3}{\sqrt[3]{3}} \cdot \frac{\sqrt[3]{9}}{\sqrt[3]{9}} = \frac{3\sqrt[3]{9}}{\sqrt[3]{27}} = \frac{3\sqrt[3]{9}}{3} = \sqrt[3]{9}$

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Exercises 0.6 (page 71)

1. numerator 2. denominator 3. $ad = bc$ 4. zero
5. $\frac{ac}{bd}$ 6. $\frac{ad}{bc}$ 7. $\frac{a+c}{b}$ 8. $\frac{a-c}{b}$
9. $\frac{8x}{3y} \stackrel{?}{=} \frac{16x}{6y}$
 $8x \cdot 6y \stackrel{?}{=} 3y \cdot 16x$
 $48xy = 48xy$
 EQUAL
10. $\frac{3x^2}{4y^2} \stackrel{?}{=} \frac{12y^2}{16x^2}$
 $3x^2 \cdot 16x^2 \stackrel{?}{=} 4y^2 \cdot 12y^2$
 $48x^4 \neq 48y^4$
 NOT EQUAL
11. $\frac{25xyz}{12ab^2c} \stackrel{?}{=} \frac{50a^2bc}{24xyz}$
 $25xyz \cdot 24xyz \stackrel{?}{=} 12ab^2c \cdot 50a^2bc$
 $600x^2y^2z^2 \neq 600a^3b^3c^2$
 NOT EQUAL
12. $\frac{15rs^2}{4rs^2} \stackrel{?}{=} \frac{37.5a^3}{10a^3}$
 $15rs^2 \cdot 10a^3 \stackrel{?}{=} 4rs^2 \cdot 37.5a^3$
 $150rs^2a^3 = 150rs^2a^3$
 EQUAL
13. $\frac{7a^2b}{21ab^2} = \frac{a \cdot 7ab}{3b \cdot 7ab} = \frac{a}{3b} \cdot \frac{7ab}{7ab} = \frac{a}{3b}$
14. $\frac{35p^3q^2}{49p^4q} = \frac{5q \cdot 7p^3q}{7p \cdot 7p^3q} = \frac{5q}{7p} \cdot \frac{7p^3q}{7p^3q} = \frac{5q}{7p}$
15. $\frac{4x}{7} \cdot \frac{2}{5a} = \frac{4x \cdot 2}{7 \cdot 5a} = \frac{8x}{35a}$
16. $\frac{-5y}{2z} \cdot \frac{4}{y^2} = \frac{-5y \cdot 4}{2z \cdot y^2} = \frac{-20y}{2y^2z} = -\frac{10}{yz}$
17. $\frac{8m}{5n} \div \frac{3m}{10n} = \frac{8m}{5n} \cdot \frac{10n}{3m} = \frac{80mn}{15mn} = \frac{16}{3}$
18. $\frac{15p}{8q} \div \frac{-5p}{16q^2} = \frac{15p}{8q} \cdot \frac{16q^2}{-5p} = \frac{240pq^2}{-40pq} = -6q$
19. $\frac{3z}{5c} + \frac{2z}{5c} = \frac{3z+2z}{5c} = \frac{5z}{5c} = \frac{z}{c}$
20. $\frac{7a}{4b} - \frac{3a}{4b} = \frac{7a-3a}{4b} = \frac{4a}{4b} = \frac{a}{b}$
21. $\frac{15x^2y}{7a^2b^3} - \frac{x^2y}{7a^2b^3} = \frac{14x^2y}{7a^2b^3} = \frac{2x^2y}{a^2b^3}$
22. $\frac{8rst^2}{15m^4t^2} + \frac{7rst^2}{15m^4t^2} = \frac{15rst^2}{15m^4t^2} = \frac{rs}{m^4}$
23. $\frac{2x-4}{x^2-4} = \frac{2(x-2)}{(x+2)(x-2)} = \frac{2}{x+2}$
24. $\frac{x^2-16}{x^2-8x+16} = \frac{(x+4)(x-4)}{(x-4)(x-4)} = \frac{x+4}{x-4}$
25. $\frac{4-x^2}{x^2-5x+6} = \frac{(2+x)(2-x)}{(x-3)(x-2)} = -\frac{x+2}{x-3}$
26. $\frac{25-x^2}{x^2+10x+25} = \frac{(5+x)(5-x)}{(x+5)(x+5)} = \frac{5-x}{x+5} = -\frac{x-5}{x+5}$
27. $\frac{6x^3+x^2-12x}{4x^3+4x^2-3x} = \frac{x(6x^2+x-12)}{x(4x^2+4x-3)} = \frac{x(2x+3)(3x-4)}{x(2x+3)(2x-1)} = \frac{3x-4}{2x-1}$

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$$28. \frac{6x^4 - 5x^3 - 6x^2}{2x^3 - 7x^2 - 15x} = \frac{x^2(6x^2 - 5x - 6)}{x(2x^2 - 7x - 15)} = \frac{x^2(2x - 3)(3x + 2)}{x(2x + 3)(x - 5)} = \frac{x(2x - 3)(3x + 2)}{(2x + 3)(x - 5)}$$

$$29. \frac{x^3 - 8}{x^2 + ax - 2x - 2a} = \frac{x^3 - 2^3}{x(x + a) - 2(x + a)} = \frac{(x - 2)(x^2 + 2x + 4)}{(x + a)(x - 2)} = \frac{x^2 + 2x + 4}{x + a}$$

$$30. \frac{xy + 2x + 3y + 6}{x^3 + 27} = \frac{x(y + 2) + 3(y + 2)}{x^3 + 3^3} = \frac{(y + 2)(x + 3)}{(x + 3)(x^2 - 3x + 9)} = \frac{y + 2}{x^2 - 3x + 9}$$

$$31. \frac{x^2 - 1}{x} \cdot \frac{x^2}{x^2 + 2x + 1} = \frac{(x + 1)(x - 1)}{x} \cdot \frac{x^2}{(x + 1)(x + 1)} = \frac{x(x - 1)}{x + 1}$$

$$32. \frac{y^2 - 2y + 1}{y} \cdot \frac{y + 2}{y^2 + y - 2} = \frac{(y - 1)(y - 1)}{y} \cdot \frac{y + 2}{(y + 2)(y - 1)} = \frac{y - 1}{y}$$

$$33. \frac{3x^2 + 7x + 2}{x^2 + 2x} \cdot \frac{x^2 - x}{3x^2 + x} = \frac{(3x + 1)(x + 2)}{x(x + 2)} \cdot \frac{x(x - 1)}{x(3x + 1)} = \frac{x - 1}{x}$$

$$34. \frac{x^2 + x}{2x^2 + 3x} \cdot \frac{2x^2 + x - 3}{x^2 - 1} = \frac{x(x + 1)}{x(2x + 3)} \cdot \frac{(2x + 3)(x - 1)}{(x + 1)(x - 1)} = 1$$

$$35. \frac{x^2 + x}{x - 1} \cdot \frac{x^2 - 1}{x + 2} = \frac{x(x + 1)}{x - 1} \cdot \frac{(x + 1)(x - 1)}{x + 2} = \frac{x(x + 1)^2}{x + 2}$$

$$36. \frac{x^2 + 5x + 6}{x^2 + 6x + 9} \cdot \frac{x + 2}{x^2 - 4} = \frac{(x + 2)(x + 3)}{(x + 3)(x + 3)} \cdot \frac{x + 2}{(x + 2)(x - 2)} = \frac{x + 2}{(x + 3)(x - 2)}$$

$$37. \frac{2x^2 + 32}{8} \div \frac{x^2 + 16}{2} = \frac{2x^2 + 32}{8} \cdot \frac{2}{x^2 + 16} = \frac{2(x^2 + 16)}{8} \cdot \frac{2}{x^2 + 16} = \frac{1}{2}$$

$$38. \frac{x^2 + x - 6}{x^2 - 6x + 9} \div \frac{x^2 - 4}{x^2 - 9} = \frac{x^2 + x - 6}{x^2 - 6x + 9} \cdot \frac{x^2 - 9}{x^2 - 4} = \frac{(x + 3)(x - 2)}{(x - 3)(x - 3)} \cdot \frac{(x + 3)(x - 3)}{(x + 2)(x - 2)}$$

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

$$39. \frac{z^2 + z - 20}{z^2 - 4} \div \frac{z^2 - 25}{z - 5} = \frac{z^2 + z - 20}{z^2 - 4} \cdot \frac{z - 5}{z^2 - 25} = \frac{(z + 5)(z - 4)}{(z + 2)(z - 2)} \cdot \frac{z - 5}{(z + 5)(z - 5)}$$

$$= \frac{z - 4}{(z + 2)(z - 2)}$$

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40.
$$\begin{aligned} \frac{ax + bx + a + b}{a^2 + 2ab + b^2} \div \frac{x^2 - 1}{x^2 - 2x + 1} &= \frac{ax + bx + a + b}{a^2 + 2ab + b^2} \cdot \frac{x^2 - 2x + 1}{x^2 - 1} \\ &= \frac{x(a + b) + 1(a + b)}{(a + b)(a + b)} \cdot \frac{(x - 1)(x - 1)}{(x + 1)(x - 1)} \\ &= \frac{(a + b)(x + 1)}{(a + b)(a + b)} \cdot \frac{(x - 1)(x - 1)}{(x + 1)(x - 1)} = \frac{x - 1}{a + b} \end{aligned}$$
41.
$$\begin{aligned} \frac{3x^2 + 5x - 2}{x^3 + 2x^2} \div \frac{6x^2 + 13x - 5}{2x^3 + 5x^2} &= \frac{3x^2 + 5x - 2}{x^3 + 2x^2} \cdot \frac{2x^3 + 5x^2}{6x^2 + 13x - 5} \\ &= \frac{(3x - 1)(x + 2)}{x^2(x + 2)} \cdot \frac{x^2(2x + 5)}{(3x - 1)(2x + 5)} = 1 \end{aligned}$$
42.
$$\begin{aligned} \frac{x^2 + 13x + 12}{8x^2 - 6x - 5} \div \frac{2x^2 - x - 3}{8x^2 - 14x + 5} &= \frac{x^2 + 13x + 12}{8x^2 - 6x - 5} \cdot \frac{8x^2 - 14x + 5}{2x^2 - x - 3} \\ &= \frac{(x + 12)(x + 1)}{(4x - 5)(2x + 1)} \cdot \frac{(4x - 5)(2x - 1)}{(2x - 3)(x + 1)} = \frac{(x + 12)(2x - 1)}{(2x + 1)(2x - 3)} \end{aligned}$$
43.
$$\begin{aligned} \frac{x^2 + 7x + 12}{x^3 - x^2 - 6x} \cdot \frac{x^2 - 3x - 10}{x^2 + 2x - 3} \cdot \frac{x^3 - 4x^2 + 3x}{x^2 - x - 20} \\ = \frac{(x + 3)(x + 4)}{x(x - 3)(x + 2)} \cdot \frac{(x - 5)(x + 2)}{(x + 3)(x - 1)} \cdot \frac{x(x - 3)(x - 1)}{(x - 5)(x + 4)} = 1 \end{aligned}$$
44.
$$\begin{aligned} \frac{x(x - 2) - 3}{x(x + 7) - 3(x - 1)} \cdot \frac{x(x + 1) - 2}{x(x - 7) + 3(x + 1)} &= \frac{x^2 - 2x - 3}{x^2 + 7x - 3x + 3} \cdot \frac{x^2 + x - 2}{x^2 - 7x + 3x + 3} \\ &= \frac{x^2 - 2x - 3}{x^2 + 4x + 3} \cdot \frac{x^2 + x - 2}{x^2 - 4x + 3} \\ &= \frac{(x - 3)(x + 1)}{(x + 3)(x + 1)} \cdot \frac{(x + 2)(x - 1)}{(x - 3)(x - 1)} = \frac{x + 2}{x + 3} \end{aligned}$$
45.
$$\begin{aligned} \frac{x^2 - 2x - 3}{21x^2 - 50x - 16} \cdot \frac{3x - 8}{x - 3} \div \frac{x^2 + 6x + 5}{7x^2 - 33x - 10} &= \frac{x^2 - 2x - 3}{21x^2 - 50x - 16} \cdot \frac{3x - 8}{x - 3} \cdot \frac{7x^2 - 33x - 10}{x^2 + 6x + 5} \\ &= \frac{(x - 3)(x + 1)}{(7x + 2)(3x - 8)} \cdot \frac{3x - 8}{x - 3} \cdot \frac{(7x + 2)(x - 5)}{(x + 5)(x + 1)} \\ &= \frac{x - 5}{x + 5} \end{aligned}$$

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$$\begin{aligned}
 46. \quad \frac{x^3 + 27}{x^2 - 4} \div \left(\frac{x^2 + 4x + 3}{x^2 + 2x} \div \frac{x^2 + x - 6}{x^2 - 3x + 9} \right) &= \frac{x^3 + 27}{x^2 - 4} \div \left(\frac{x^2 + 4x + 3}{x^2 + 2x} \cdot \frac{x^2 - 3x + 9}{x^2 + x - 6} \right) \\
 &= \frac{x^3 + 27}{x^2 - 4} \div \left(\frac{(x+3)(x+1)}{x(x+2)} \cdot \frac{x^2 - 3x + 9}{(x+3)(x-2)} \right) \\
 &= \frac{x^3 + 27}{x^2 - 4} \div \frac{(x+1)(x^2 - 3x + 9)}{x(x+2)(x-2)} \\
 &= \frac{(x+3)(x^2 - 3x + 9)}{(x+2)(x-2)} \cdot \frac{x(x+2)(x-2)}{(x+1)(x^2 - 3x + 9)} \\
 &= \frac{x(x+3)}{x+1}
 \end{aligned}$$

$$47. \quad \frac{3}{x+3} + \frac{x+2}{x+3} = \frac{3+x+2}{x+3} = \frac{x+5}{x+3}$$

$$48. \quad \frac{3}{x+1} + \frac{x+2}{x+1} = \frac{3+x+2}{x+1} = \frac{x+5}{x+1}$$

$$49. \quad \frac{4x}{x-1} - \frac{4}{x-1} = \frac{4x-4}{x-1} = \frac{4(x-1)}{x-1} = 4$$

$$50. \quad \frac{6x}{x-2} - \frac{3}{x-2} = \frac{6x-3}{x-2} = \frac{3(2x-1)}{x-2}$$

$$51. \quad \frac{2}{5-x} + \frac{1}{x-5} = \frac{-2}{x-5} + \frac{1}{x-5} = \frac{-1}{x-5}$$

$$52. \quad \frac{3}{x-6} - \frac{2}{6-x} = \frac{3}{x-6} - \frac{-2}{x-6} = \frac{5}{x-6}$$

$$\begin{aligned}
 53. \quad \frac{3}{x+1} + \frac{2}{x-1} &= \frac{3(x-1)}{(x+1)(x-1)} + \frac{2(x+1)}{(x-1)(x+1)} = \frac{3x-3}{(x+1)(x-1)} + \frac{2x+2}{(x-1)(x+1)} \\
 &= \frac{5x-1}{(x+1)(x-1)}
 \end{aligned}$$

$$\begin{aligned}
 54. \quad \frac{3}{x+4} + \frac{x}{x-4} &= \frac{3(x-4)}{(x+4)(x-4)} + \frac{x(x+4)}{(x-4)(x+4)} = \frac{3x-12}{(x+4)(x-4)} + \frac{x^2+4x}{(x-4)(x+4)} \\
 &= \frac{x^2+7x-12}{(x+4)(x-4)}
 \end{aligned}$$

$$\begin{aligned}
 55. \quad \frac{a+3}{a^2+7a+12} + \frac{a}{a^2-16} &= \frac{a+3}{(a+3)(a+4)} + \frac{a}{(a+4)(a-4)} \\
 &= \frac{1}{a+4} + \frac{a}{(a+4)(a-4)} \\
 &= \frac{1(a-4)}{(a+4)(a-4)} + \frac{a}{(a+4)(a-4)} \\
 &= \frac{a-4}{(a+4)(a-4)} + \frac{a}{(a+4)(a-4)} \\
 &= \frac{2a-4}{(a+4)(a-4)} = \frac{2(a-2)}{(a+4)(a-4)}
 \end{aligned}$$

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$$\begin{aligned}
 56. \quad \frac{a}{a^2 + a - 2} + \frac{2}{a^2 - 5a + 4} &= \frac{a}{(a+2)(a-1)} + \frac{2}{(a-4)(a-1)} \\
 &= \frac{a(a-4)}{(a+2)(a-1)(a-4)} + \frac{2(a+2)}{(a-4)(a-1)(a+2)} \\
 &= \frac{a^2 - 4a}{(a+2)(a-1)(a-4)} + \frac{2a+4}{(a+2)(a-1)(a-4)} \\
 &= \frac{a^2 - 2a + 4}{(a+2)(a-1)(a-4)}
 \end{aligned}$$

$$\begin{aligned}
 57. \quad \frac{x}{x^2 - 4} - \frac{1}{x + 2} &= \frac{x}{(x+2)(x-2)} - \frac{1}{x+2} = \frac{x}{(x+2)(x-2)} - \frac{1(x-2)}{(x+2)(x-2)} \\
 &= \frac{x}{(x+2)(x-2)} - \frac{x-2}{(x+2)(x-2)} \\
 &= \frac{2}{(x+2)(x-2)}
 \end{aligned}$$

$$\begin{aligned}
 58. \quad \frac{b^2}{b^2 - 4} - \frac{4}{b^2 + 2b} &= \frac{b^2}{(b+2)(b-2)} - \frac{4}{b(b+2)} = \frac{b^2(b)}{b(b+2)(b-2)} - \frac{4(b-2)}{b(b+2)(b-2)} \\
 &= \frac{b^3}{b(b+2)(b-2)} - \frac{4b-8}{b(b+2)(b-2)} \\
 &= \frac{b^3 - 4b + 8}{b(b+2)(b-2)}
 \end{aligned}$$

$$\begin{aligned}
 59. \quad \frac{3x-2}{x^2 + 2x + 1} - \frac{x}{x^2 - 1} &= \frac{3x-2}{(x+1)(x+1)} - \frac{x}{(x+1)(x-1)} \\
 &= \frac{(3x-2)(x-1)}{(x+1)(x+1)(x-1)} - \frac{x(x+1)}{(x+1)(x-1)(x+1)} \\
 &= \frac{3x^2 - 5x + 2}{(x+1)(x+1)(x-1)} - \frac{x^2 + x}{(x+1)(x+1)(x-1)} \\
 &= \frac{2x^2 - 6x + 2}{(x+1)(x+1)(x-1)} = \frac{2(x^2 - 3x + 1)}{(x+1)^2(x-1)}
 \end{aligned}$$

$$\begin{aligned}
 60. \quad \frac{2t}{t^2 - 25} - \frac{t+1}{t^2 + 5t} &= \frac{2t}{(t+5)(t-5)} - \frac{t+1}{t(t+5)} = \frac{2t(t)}{t(t+5)(t-5)} - \frac{(t+1)(t-5)}{t(t+5)(t-5)} \\
 &= \frac{2t^2}{t(t+5)(t-5)} - \frac{t^2 - 4t - 5}{t(t+5)(t-5)} \\
 &= \frac{t^2 + 4t + 5}{t(t+5)(t-5)}
 \end{aligned}$$

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$$\begin{aligned}
 61. \quad \frac{2}{y^2-1} + 3 + \frac{1}{y+1} &= \frac{2}{(y+1)(y-1)} + \frac{3}{1} + \frac{1}{y+1} \\
 &= \frac{2}{(y+1)(y-1)} + \frac{3(y+1)(y-1)}{1(y+1)(y-1)} + \frac{1(y-1)}{(y+1)(y-1)} \\
 &= \frac{2}{(y+1)(y-1)} + \frac{3y^2-3}{(y+1)(y-1)} + \frac{y-1}{(y+1)(y-1)} \\
 &= \frac{3y^2+y-2}{(y+1)(y-1)} = \frac{(3y-2)(y+1)}{(y+1)(y-1)} = \frac{3y-2}{y-1}
 \end{aligned}$$

$$\begin{aligned}
 62. \quad 2 + \frac{4}{t^2-4} - \frac{1}{t-2} &= \frac{2}{1} + \frac{4}{(t+2)(t-2)} - \frac{1}{t-2} \\
 &= \frac{2(t+2)(t-2)}{1(t+2)(t-2)} + \frac{4}{(t+2)(t-2)} - \frac{1(t+2)}{(t+2)(t-2)} \\
 &= \frac{2t^2-8}{(t+2)(t-2)} + \frac{4}{(t+2)(t-2)} - \frac{t+2}{(t+2)(t-2)} \\
 &= \frac{2t^2-t-6}{(t+2)(t-2)} = \frac{(2t+3)(t-2)}{(t+2)(t-2)} = \frac{2t+3}{t+2}
 \end{aligned}$$

$$\begin{aligned}
 63. \quad \frac{1}{x-2} + \frac{3}{x+2} - \frac{3x-2}{x^2-4} &= \frac{1}{x-2} + \frac{3}{x+2} - \frac{3x-2}{(x+2)(x-2)} \\
 &= \frac{1(x+2)}{(x-2)(x+2)} + \frac{3(x-2)}{(x+2)(x-2)} - \frac{3x-2}{(x+2)(x-2)} \\
 &= \frac{x+2}{(x+2)(x-2)} + \frac{3x-6}{(x+2)(x-2)} - \frac{3x-2}{(x+2)(x-2)} \\
 &= \frac{x-2}{(x+2)(x-2)} = \frac{1}{x+2}
 \end{aligned}$$

$$\begin{aligned}
 64. \quad \frac{x}{x-3} - \frac{5}{x+3} + \frac{3(3x-1)}{x^2-9} &= \frac{x}{x-3} - \frac{5}{x+3} + \frac{9x-3}{(x+3)(x-3)} \\
 &= \frac{x(x+3)}{(x-3)(x+3)} - \frac{5(x-3)}{(x+3)(x-3)} + \frac{9x-3}{(x+3)(x-3)} \\
 &= \frac{x^2+3x}{(x+3)(x-3)} - \frac{5x-15}{(x+3)(x-3)} + \frac{9x-3}{(x+3)(x-3)} \\
 &= \frac{x^2+7x+12}{(x+3)(x-3)} = \frac{(x+3)(x+4)}{(x+3)(x-3)} = \frac{x+4}{x-3}
 \end{aligned}$$

$$\begin{aligned}
 65. \quad \left(\frac{1}{x-2} + \frac{1}{x-3} \right) \cdot \frac{x-3}{2x} &= \left(\frac{1(x-3)}{(x-2)(x-3)} + \frac{1(x-2)}{(x-3)(x-2)} \right) \cdot \frac{x-3}{2x} \\
 &= \left(\frac{x-3}{(x-2)(x-3)} + \frac{x-2}{(x-2)(x-3)} \right) \cdot \frac{x-3}{2x} \\
 &= \frac{2x-5}{(x-2)(x-3)} \cdot \frac{x-3}{2x} = \frac{2x-5}{2x(x-2)}
 \end{aligned}$$

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$$\begin{aligned}
 66. \quad \left(\frac{1}{x+1} - \frac{1}{x-2} \right) \div \frac{1}{x-2} &= \left(\frac{1(x-2)}{(x+1)(x-2)} - \frac{1(x+1)}{(x-2)(x+1)} \right) \cdot \frac{x-2}{1} \\
 &= \left(\frac{x-2}{(x+1)(x-2)} - \frac{x+1}{(x+1)(x-2)} \right) \cdot \frac{x-2}{1} \\
 &= \frac{-3}{(x+1)(x-2)} \cdot \frac{x-2}{1} = \frac{-3}{x+1}
 \end{aligned}$$

$$\begin{aligned}
 67. \quad \frac{3x}{x-4} - \frac{x}{x+4} - \frac{3x+1}{16-x^2} &= \frac{3x}{x-4} - \frac{x}{x+4} - \frac{3x+1}{(4+x)(4-x)} \\
 &= \frac{3x}{x-4} - \frac{x}{x+4} + \frac{3x+1}{(x+4)(x-4)} \\
 &= \frac{3x(x+4)}{(x-4)(x+4)} - \frac{x(x-4)}{(x+4)(x-4)} + \frac{3x+1}{(x+4)(x-4)} \\
 &= \frac{3x^2+12x}{(x+4)(x-4)} - \frac{x^2-4x}{(x+4)(x-4)} + \frac{3x+1}{(x+4)(x-4)} \\
 &= \frac{2x^2+19x+1}{(x+4)(x-4)}
 \end{aligned}$$

$$\begin{aligned}
 68. \quad \frac{7x}{x-5} + \frac{3x}{5-x} + \frac{3x-1}{x^2-25} &= \frac{7x}{x-5} + \frac{-3x}{x-5} + \frac{3x-1}{(x+5)(x-5)} \\
 &= \frac{4x}{x-5} + \frac{3x-1}{(x+5)(x-5)} \\
 &= \frac{4x(x+5)}{(x-5)(x+5)} + \frac{3x-1}{(x+5)(x-5)} \\
 &= \frac{4x^2+20x}{(x+5)(x-5)} + \frac{3x-1}{(x+5)(x-5)} = \frac{4x^2+23x-1}{(x+5)(x-5)}
 \end{aligned}$$

$$\begin{aligned}
 69. \quad \frac{1}{x^2+3x+2} - \frac{2}{x^2+4x+3} + \frac{1}{x^2+5x+6} &= \frac{1}{(x+2)(x+1)} - \frac{2}{(x+3)(x+1)} + \frac{1}{(x+2)(x+3)} \\
 &= \frac{1(x+3)}{(x+2)(x+1)(x+3)} - \frac{2(x+2)}{(x+3)(x+1)(x+2)} + \frac{1(x+1)}{(x+2)(x+3)(x+1)} \\
 &= \frac{x+3}{(x+2)(x+1)(x+3)} - \frac{2x+4}{(x+2)(x+1)(x+3)} + \frac{x+1}{(x+2)(x+1)(x+3)} \\
 &= \frac{x+3-2x-4+x+1}{(x+2)(x+1)(x+3)} = \frac{0}{(x+2)(x+1)(x+3)} = 0
 \end{aligned}$$

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$$\begin{aligned}
70. \quad \frac{-2}{x-y} + \frac{2}{x-z} - \frac{2z-2y}{(y-x)(z-x)} &= \frac{2}{y-x} + \frac{-2}{z-x} - \frac{2z-2y}{(y-x)(z-x)} \\
&= \frac{2(z-x)}{(y-x)(z-x)} + \frac{-2(y-x)}{(z-x)(y-x)} - \frac{2z-2y}{(y-x)(z-x)} \\
&= \frac{2z-2x}{(y-x)(z-x)} + \frac{-2y+2x}{(y-x)(z-x)} - \frac{2z-2y}{(y-x)(z-x)} \\
&= \frac{2z-2x-2y+2x-2z+2y}{(y-x)(z-x)} = \frac{0}{(y-x)(z-x)} = 0
\end{aligned}$$

$$\begin{aligned}
71. \quad \frac{3x-2}{x^2+x-20} - \frac{4x^2+2}{x^2-25} + \frac{3x^2-25}{x^2-16} \\
&= \frac{3x-2}{(x+5)(x-4)} - \frac{4x^2+2}{(x+5)(x-5)} + \frac{3x^2-25}{(x+4)(x-4)} \\
&= \frac{(3x-2)(x-5)(x+4)}{(x+5)(x-4)(x-5)(x+4)} - \frac{(4x^2+2)(x-4)(x+4)}{(x+5)(x-5)(x-4)(x+4)} \dots \\
&\quad + \frac{(3x^2-25)(x+5)(x-5)}{(x+4)(x-4)(x+5)(x-5)} \\
&= \frac{3x^3-5x^2-58x+40}{(x+5)(x-4)(x-5)(x+4)} - \frac{4x^4-62x^2-32}{(x+5)(x-4)(x-5)(x+4)} \dots \\
&\quad + \frac{3x^4-100x^2+625}{(x+5)(x-4)(x-5)(x+4)} \\
&= \frac{3x^3-5x^2-58x+40-4x^4+62x^2+32+3x^4-100x^2+625}{(x+5)(x-4)(x-5)(x+4)} \\
&= \frac{-x^4+3x^3-43x^2-58x+697}{(x+5)(x-4)(x-5)(x+4)}
\end{aligned}$$

$$\begin{aligned}
72. \quad \frac{3x+2}{8x^2-10x-3} + \frac{x+4}{6x^2-11x+3} - \frac{1}{4x+1} \\
&= \frac{3x+2}{(4x+1)(2x-3)} + \frac{x+4}{(3x-1)(2x-3)} - \frac{1}{4x+1} \\
&= \frac{(3x+2)(3x-1)}{(4x+1)(2x-3)(3x-1)} + \frac{(x+4)(4x+1)}{(3x-1)(2x-3)(4x+1)} - \frac{1(2x-3)(3x-1)}{(4x+1)(2x-3)(3x-1)} \\
&= \frac{9x^2+3x-2}{(4x+1)(2x-3)(3x-1)} + \frac{4x^2+17x+4}{(4x+1)(2x-3)(3x-1)} - \frac{6x^2-11x+3}{(4x+1)(2x-3)(3x-1)} \\
&= \frac{9x^2+3x-2+4x^2+17x+4-6x^2+11x-3}{(4x+1)(2x-3)(3x-1)} = \frac{7x^2+31x-1}{(4x+1)(2x-3)(3x-1)}
\end{aligned}$$

$$73. \quad \frac{\frac{3a}{b}}{\frac{6ac}{b^2}} = \frac{3a}{b} \div \frac{6ac}{b^2} = \frac{3a}{b} \cdot \frac{b^2}{6ac} = \frac{b}{2c}$$

$$74. \quad \frac{\frac{3t^2}{9x}}{\frac{t}{18x}} = \frac{3t^2}{9x} \div \frac{t}{18x} = \frac{3t^2}{9x} \cdot \frac{18x}{t} = 6t$$

$$75. \quad \frac{3a^2b}{\frac{ab}{27}} = \frac{3a^2b}{1} \div \frac{ab}{27} = \frac{3a^2b}{1} \cdot \frac{27}{ab} = 81a$$

$$76. \quad \frac{\frac{3u^2v}{4t}}{3uv} = \frac{3u^2v}{4t} \div \frac{3uv}{1} = \frac{3u^2v}{4t} \cdot \frac{1}{3uv} = \frac{u}{4t}$$

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$$77. \frac{\frac{x-y}{ab}}{\frac{y-x}{ab}} = \frac{x-y}{ab} \div \frac{y-x}{ab} = \frac{x-y}{ab} \cdot \frac{ab}{y-x} = -1$$

$$78. \frac{\frac{x^2-5x+6}{2x^2y}}{\frac{x^2-9}{2x^2y}} = \frac{x^2-5x+6}{2x^2y} \div \frac{x^2-9}{2x^2y} = \frac{x^2-5x+6}{2x^2y} \cdot \frac{2x^2y}{x^2-9} \\ = \frac{(x-3)(x-2)}{2x^2y} \cdot \frac{2x^2y}{(x+3)(x-3)} = \frac{x-2}{x+3}$$

$$79. \frac{\frac{1}{x} + \frac{1}{y}}{xy} = \frac{xy\left(\frac{1}{x} + \frac{1}{y}\right)}{xy(xy)} = \frac{xy\left(\frac{1}{x}\right) + xy\left(\frac{1}{y}\right)}{x^2y^2} = \frac{y+x}{x^2y^2}$$

$$80. \frac{\frac{xy}{\frac{11}{x} + \frac{11}{y}}}{\frac{xy}{\frac{11}{x} + \frac{11}{y}}} = \frac{xy(xy)}{xy\left(\frac{11}{x} + \frac{11}{y}\right)} = \frac{x^2y^2}{xy\left(\frac{11}{x}\right) + xy\left(\frac{11}{y}\right)} = \frac{x^2y^2}{11y + 11x} = \frac{x^2y^2}{11(y+x)}$$

$$81. \frac{\frac{1}{x} + \frac{1}{y}}{\frac{1}{x} - \frac{1}{y}} = \frac{xy\left(\frac{1}{x} + \frac{1}{y}\right)}{xy\left(\frac{1}{x} - \frac{1}{y}\right)} = \frac{xy\left(\frac{1}{x}\right) + xy\left(\frac{1}{y}\right)}{xy\left(\frac{1}{x}\right) - xy\left(\frac{1}{y}\right)} = \frac{y+x}{y-x}$$

$$82. \frac{\frac{1}{x} - \frac{1}{y}}{\frac{1}{x} + \frac{1}{y}} = \frac{xy\left(\frac{1}{x} - \frac{1}{y}\right)}{xy\left(\frac{1}{x} + \frac{1}{y}\right)} = \frac{xy\left(\frac{1}{x}\right) - xy\left(\frac{1}{y}\right)}{xy\left(\frac{1}{x}\right) + xy\left(\frac{1}{y}\right)} = \frac{y-x}{y+x}$$

$$83. \frac{\frac{3a}{b} - \frac{4a^2}{x}}{\frac{1}{b} + \frac{1}{ax}} = \frac{abx\left(\frac{3a}{b} - \frac{4a^2}{x}\right)}{abx\left(\frac{1}{b} + \frac{1}{ax}\right)} = \frac{abx\left(\frac{3a}{b}\right) - abx\left(\frac{4a^2}{x}\right)}{abx\left(\frac{1}{b}\right) + abx\left(\frac{1}{ax}\right)} = \frac{3a^2x - 4a^3b}{ax+b} = \frac{a^2(3x-4ab)}{ax+b}$$

$$84. \frac{1 - \frac{x}{y}}{\frac{x^2}{y^2} - 1} = \frac{y^2\left(1 - \frac{x}{y}\right)}{y^2\left(\frac{x^2}{y^2} - 1\right)} = \frac{y^2(1) - y^2\left(\frac{x}{y}\right)}{y^2\left(\frac{x^2}{y^2}\right) - y^2(1)} = \frac{y^2 - xy}{x^2 - y^2} = \frac{y(y-x)}{(x+y)(x-y)} = \frac{-y}{x+y}$$

$$85. \frac{x+1 - \frac{6}{x}}{x+5 + \frac{6}{x}} = \frac{x\left(x+1 - \frac{6}{x}\right)}{x\left(x+5 + \frac{6}{x}\right)} = \frac{x(x) + x(1) - x\left(\frac{6}{x}\right)}{x(x) + x(5) + x\left(\frac{6}{x}\right)} = \frac{x^2 + x - 6}{x^2 + 5x + 6} = \frac{(x+3)(x-2)}{(x+2)(x+3)} = \frac{x-2}{x+2}$$

$$86. \frac{2z}{1 - \frac{3}{z}} = \frac{z(2z)}{z\left(1 - \frac{3}{z}\right)} = \frac{2z^2}{z(1) - z\left(\frac{3}{z}\right)} = \frac{2z^2}{z-3}$$

$$87. \frac{3xy}{1 - \frac{1}{xy}} = \frac{xy(3xy)}{xy\left(1 - \frac{1}{xy}\right)} = \frac{3x^2y^2}{xy(1) - xy\left(\frac{1}{xy}\right)} = \frac{3x^2y^2}{xy-1}$$

$$88. \frac{x-3 + \frac{1}{x}}{-\frac{1}{x} - x + 3} = \frac{x\left(x-3 + \frac{1}{x}\right)}{x\left(-\frac{1}{x} - x + 3\right)} = \frac{x^2 - 3x + 1}{-1 - x^2 + 3x} = \frac{x^2 - 3x + 1}{-(x^2 - 3x + 1)} = -1$$

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

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$$90. \quad \frac{2x^2 + 4}{2 + \frac{4x}{5}} = \frac{5(2x^2 + 4)}{5(2 + \frac{4x}{5})} = \frac{10x^2 + 20}{10 + 4x} = \frac{2(5x^2 + 10)}{2(5 + 2x)} = \frac{5x^2 + 10}{5 + 2x}$$

$$91. \quad \frac{\frac{x}{x+2} - \frac{2}{x-1}}{\frac{3}{x+2} + \frac{x}{x-1}} = \frac{(x+2)(x-1)\left(\frac{x}{x+2} - \frac{2}{x-1}\right)}{(x+2)(x-1)\left(\frac{3}{x+2} + \frac{x}{x-1}\right)} = \frac{(x+2)(x-1)\left(\frac{x}{x+2}\right) - (x+2)(x-1)\left(\frac{2}{x-1}\right)}{(x+2)(x-1)\left(\frac{3}{x+2}\right) + (x+2)(x-1)\left(\frac{x}{x-1}\right)}$$

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

$$= \frac{x^2 - x - 2x - 4}{3x - 3 + x^2 + 2x} = \frac{x^2 - 3x - 4}{x^2 + 5x - 3}$$

$$92. \quad \frac{\frac{2x}{x-3} + \frac{1}{x-2}}{\frac{3}{x-3} - \frac{x}{x-2}} = \frac{(x-3)(x-2)\left(\frac{2x}{x-3} + \frac{1}{x-2}\right)}{(x-3)(x-2)\left(\frac{3}{x-3} - \frac{x}{x-2}\right)} = \frac{(x-3)(x-2)\left(\frac{2x}{x-3}\right) + (x-3)(x-2)\left(\frac{1}{x-2}\right)}{(x-3)(x-2)\left(\frac{3}{x-3}\right) - (x-3)(x-2)\left(\frac{x}{x-2}\right)}$$

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

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

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

$$93. \quad \frac{1}{1 + x^{-1}} = \frac{1}{1 + \frac{1}{x}} = \frac{x(1)}{x\left(1 + \frac{1}{x}\right)} = \frac{x}{x + 1}$$

$$94. \quad \frac{y^{-1}}{x^{-1} + y^{-1}} = \frac{\frac{1}{y}}{\frac{1}{x} + \frac{1}{y}} = \frac{xy\left(\frac{1}{y}\right)}{xy\left(\frac{1}{x} + \frac{1}{y}\right)} = \frac{x}{y + x}$$

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

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

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

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

$$96. \quad \frac{2x(x-3)^{-1} - 3(x+2)^{-1}}{(x-3)^{-1}(x+2)^{-1}} = \frac{\frac{2x}{x-3} - \frac{3}{x+2}}{\frac{1}{(x-3)(x+2)}} = \frac{(x-3)(x+2)\left(\frac{2x}{x-3} - \frac{3}{x+2}\right)}{(x-3)(x+2)\left(\frac{1}{(x-3)(x+2)}\right)}$$

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

$$= 2x^2 + 4x - 3x + 9 = 2x^2 + x + 9$$

$$97. \quad \frac{1}{\frac{1}{k_1} + \frac{1}{k_2}} = \frac{k_1 k_2 (1)}{k_1 k_2 \left(\frac{1}{k_1} + \frac{1}{k_2}\right)} = \frac{k_1 k_2}{k_1 k_2 \left(\frac{1}{k_1}\right) + k_1 k_2 \left(\frac{1}{k_2}\right)} = \frac{k_1 k_2}{k_2 + k_1}$$

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$$98. \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{R_1 R_2 R_3 (1)}{R_1 R_2 R_3 \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)} = \frac{R_1 R_2 R_3}{R_1 R_2 R_3 \left(\frac{1}{R_1} \right) + R_1 R_2 R_3 \left(\frac{1}{R_2} \right) + R_1 R_2 R_3 \left(\frac{1}{R_3} \right)}$$

$$= \frac{R_1 R_2 R_3}{R_2 R_3 + R_1 R_3 + R_1 R_2}$$

$$99. \frac{x}{1 + \frac{1}{3x^{-1}}} = \frac{x}{1 + \frac{1}{\frac{3}{x}}} = \frac{x}{1 + \frac{x(1)}{x(\frac{3}{x})}} = \frac{x}{1 + \frac{x}{3}} = \frac{3x}{3(1 + \frac{x}{3})} = \frac{3x}{3 + x}$$

$$100. \frac{ab}{2 + \frac{3}{2a^{-1}}} = \frac{ab}{2 + \frac{3}{\frac{2}{a}}} = \frac{ab}{2 + \frac{a(3)}{a(\frac{2}{a})}} = \frac{ab}{2 + \frac{3a}{2}} = \frac{2ab}{2(2 + \frac{3a}{2})} = \frac{2ab}{4 + 3a}$$

$$101. \frac{1}{1 + \frac{1}{1 + \frac{1}{x}}} = \frac{1}{1 + \frac{x(1)}{x(1 + \frac{1}{x})}} = \frac{1}{1 + \frac{x}{x+1}} = \frac{(x+1)1}{(x+1)(1 + \frac{x}{x+1})} = \frac{x+1}{x+1+x} = \frac{x+1}{2x+1}$$

$$102. \frac{y}{2 + \frac{2}{2 + \frac{2}{y}}} = \frac{y}{2 + \frac{y(2)}{y(2 + \frac{2}{y})}} = \frac{y}{2 + \frac{2y}{2y+2}} = \frac{(2y+2)(y)}{(2y+2)(2 + \frac{2y}{2y+2})} = \frac{2y^2 + 2y}{(2y+2)(2) + 2y}$$

$$= \frac{2y(y+1)}{4y + 4 + 2y}$$

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

103-106. Answers may vary.

107. Since $-6 < 0$, $|-6| = -(-6) = 6$.

108. If $x < 0$, then $5 - x \geq 0$. Then $|5 - x| = 5 - x$.

$$109. \left(\frac{x^3 y^{-2}}{x^{-1} y} \right)^{-3} = \left(\frac{x^{-1} y}{x^3 y^{-2}} \right)^3 = \left(\frac{y^2 y}{x^3 x} \right)^3 = \left(\frac{y^3}{x^4} \right)^3 = \frac{y^9}{x^{12}}$$

$$110. (27x^6)^{2/3} = 27^{2/3} (x^6)^{2/3} = (27^{1/3})^2 x^{12/3} = 3^2 x^4 = 9x^4$$

$$111. \sqrt{20} - \sqrt{45} = \sqrt{4}\sqrt{5} - \sqrt{9}\sqrt{5} = 2\sqrt{5} - 3\sqrt{5} = -\sqrt{5}$$

$$112. 2(x^2 + 4) - 3(2x^2 + 5) = 2(x^2) + 2(4) - 3(2x^2) - 3(5) = 2x^2 + 8 - 6x^2 - 15 = -4x^2 - 7$$

Chapter 0 Review (page 75)

1. natural: 3, 6, 8

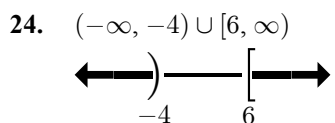
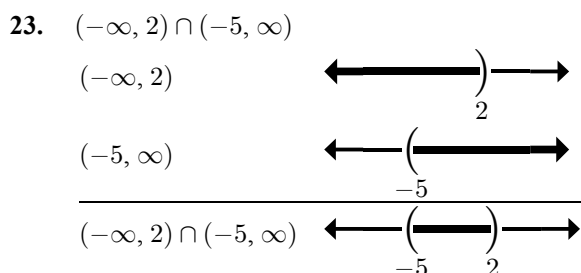
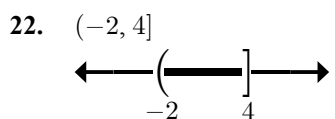
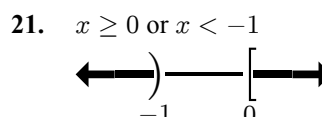
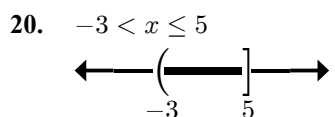
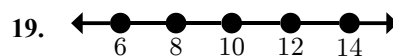
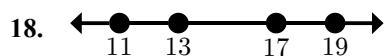
2. whole: 0, 3, 6, 8

3. integers: $-6, -3, 0, 3, 6, 8$

4. rational: $-6, -3, 0, \frac{1}{2}, 3, 6, 8$

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- | | |
|---|--|
| <p>5. irrational: $\pi, \sqrt{5}$</p> <p>7. prime: 3</p> <p>9. even integers: $-6, 0, 6, 8$</p> <p>11. associative property of addition</p> <p>13. associative property of multiplication</p> <p>15. commutative property of multiplication</p> <p>17. double negative rule</p> | <p>6. real: $-6, -3, 0, \frac{1}{2}, 3, \pi, \sqrt{5}, 6, 8$</p> <p>8. composite: 6, 8</p> <p>10. odd integers: $-3, 3$</p> <p>12. commutative property of addition</p> <p>14. distributive property</p> <p>16. commutative property of addition</p> |
|---|--|



- | | |
|---|---|
| <p>25. Since $6 \geq 0$, $6 = 6$.</p> <p>27. Since $1 - \sqrt{2} < 0$,
 $1 - \sqrt{2} = -(1 - \sqrt{2}) = \sqrt{2} - 1$.</p> <p>29. distance = $7 - (-5) = 12 = 12$</p> | <p>26. Since $-25 < 0$, $-25 = -(-25) = 25$.</p> <p>28. Since $\sqrt{3} - 1 \geq 0$,
 $\sqrt{3} - 1 = \sqrt{3} - 1$.</p> |
|---|---|

CHAPTER 0 REVIEW

30. $-5a^3 = -5aaa$

31. $(-5a)^2 = (-5a)(-5a)$

32. $3ttt = 3t^3$

33. $(-2b)(3b) = (-2)(3)bb = -6b^2$

34. $n^2n^4 = n^{2+4} = n^6$

35. $(p^3)^2 = p^{3 \cdot 2} = p^6$

36. $(x^3y^2)^4 = (x^3)^4(y^2)^4 = x^{12}y^8$

37. $\left(\frac{a^4}{b^2}\right)^3 = \frac{(a^4)^3}{(b^2)^3} = \frac{a^{12}}{b^6}$

38. $(m^{-3}n^0)^2 = (m^{-3} \cdot 1)^2 = m^{-6} = \frac{1}{m^6}$

39. $\left(\frac{p^{-2}q^2}{2}\right)^3 = \left(\frac{q^2}{2p^2}\right)^3 = \frac{(q^2)^3}{(2p^2)^3} = \frac{q^6}{8p^6}$

40. $\frac{a^5}{a^8} = a^{5-8} = a^{-3} = \frac{1}{a^3}$

41. $\left(\frac{a^2}{b^3}\right)^{-2} = \left(\frac{b^3}{a^2}\right)^2 = \frac{b^6}{a^4}$

42. $\left(\frac{3x^2y^{-2}}{x^2y^2}\right)^{-2} = \left(\frac{x^2y^2}{3x^2y^{-2}}\right)^2 = \left(\frac{x^2y^2y^2}{3x^2}\right)^2 = \left(\frac{y^4}{3}\right)^2 = \frac{y^8}{9}$

43. $\left(\frac{a^{-3}b^2}{ab^{-3}}\right)^{-2} = \left(\frac{ab^{-3}}{a^{-3}b^2}\right)^2 = \left(\frac{aa^3}{b^2b^3}\right)^2 = \left(\frac{a^4}{b^5}\right)^2 = \frac{a^8}{b^{10}}$

44. $\left(\frac{-3x^3y}{xy^3}\right)^{-2} = \left(\frac{xy^3}{-3x^3y}\right)^2 = \left(\frac{y^2}{-3x^2}\right)^2 = \frac{y^4}{9x^4}$

45. $\left(-\frac{2m^{-2}n^0}{4m^2n^{-1}}\right)^{-3} = \left(-\frac{4m^2n^{-1}}{2m^{-2}n^0}\right)^3 = \left(-\frac{2m^2m^2}{n^1n^0}\right)^3 = \left(-\frac{2m^4}{n}\right)^3 = -\frac{8m^{12}}{n^3}$

46. $-x^2 - xy^2 = -(-3)^2 - (-3)(3)^2 = -(+9) - (-3)(9) = -9 - (-27) = -9 + 27 = 18$

47. $6,750 = 6.750 \times 10^3$

48. $0.00023 = 2.3 \times 10^{-4}$

49. $4.8 \times 10^2 = 480$

50. $0.25 \times 10^{-3} = 0.00025$

51. $\frac{(45,000)(350,000)}{0.000105} = \frac{(4.5 \times 10^4)(3.5 \times 10^5)}{1.05 \times 10^{-4}} = \frac{4.5 \times 3.5 \times 10^4 \times 10^5}{1.05 \times 10^{-4}} = \frac{15.75 \times 10^9}{1.05 \times 10^{-4}} = 15 \times 10^{13} = 1.5 \times 10^{14}$

52. $121^{1/2} = (11^2)^{1/2} = 11$

53. $\left(\frac{27}{125}\right)^{1/3} = \left[\left(\frac{3}{5}\right)^3\right]^{1/3} = \frac{3}{5}$

54. $(32x^5)^{1/5} = 32^{1/5}(x^5)^{1/5} = 2x$

55. $(81a^4)^{1/4} = 81^{1/4}(a^4)^{1/4} = 3|a|$

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$$56. \quad (-1,000x^6)^{1/3} = (-1,000)^{1/3}(x^6)^{1/3} \\ = -10x^2$$

$$57. \quad (-25x^2)^{1/2} = (-25)^{1/2}(x^2)^{1/2} \\ \Rightarrow \text{not a real number}$$

$$58. \quad (x^{12}y^2)^{1/2} = (x^{12})^{1/2}(y^2)^{1/2} = x^6|y|$$

$$59. \quad \left(\frac{x^{12}}{y^4}\right)^{-1/2} = \left(\frac{y^4}{x^{12}}\right)^{1/2} = \frac{y^2}{x^6}$$

$$60. \quad \left(\frac{-c^{2/3}c^{5/3}}{c^{-2/3}}\right)^{1/3} = \left(\frac{-c^{7/3}}{c^{-2/3}}\right)^{1/3} = (-c^{9/3})^{1/3} = (-c^3)^{1/3} = -c$$

$$61. \quad \left(\frac{a^{-1/4}a^{3/4}}{a^{9/2}}\right)^{-1/2} = \left(\frac{a^{9/2}}{a^{-1/4}a^{3/4}}\right)^{1/2} = \left(\frac{a^{9/2}}{a^{2/4}}\right)^{1/2} = \left(\frac{a^{9/2}}{a^{1/2}}\right)^{1/2} = (a^{8/2})^{1/2} = (a^4)^{1/2} = a^2$$

$$62. \quad 64^{2/3} = (64^{1/3})^2 = 4^2 = 16$$

$$63. \quad 32^{-3/5} = \frac{1}{32^{3/5}} = \frac{1}{(32^{1/5})^3} = \frac{1}{2^3} = \frac{1}{8}$$

$$64. \quad \left(\frac{16}{81}\right)^{3/4} = \frac{16^{3/4}}{81^{3/4}} = \frac{(16^{1/4})^3}{(81^{1/4})^3} = \frac{2^3}{3^3} = \frac{8}{27}$$

$$65. \quad \left(\frac{32}{243}\right)^{2/5} = \frac{32^{2/5}}{243^{2/5}} = \frac{(32^{1/5})^2}{(243^{1/5})^2} = \frac{2^2}{3^2} = \frac{4}{9}$$

$$66. \quad \left(\frac{8}{27}\right)^{-2/3} = \left(\frac{27}{8}\right)^{2/3} = \frac{27^{2/3}}{8^{2/3}} = \frac{(27^{1/3})^2}{(8^{1/3})^2} = \frac{3^2}{2^2} = \frac{9}{4}$$

$$67. \quad \left(\frac{16}{625}\right)^{-3/4} = \left(\frac{625}{16}\right)^{3/4} = \frac{625^{3/4}}{16^{3/4}} = \frac{(625^{1/4})^3}{(16^{1/4})^3} = \frac{5^3}{2^3} = \frac{125}{8}$$

$$68. \quad (-216x^3)^{2/3} = (-216)^{2/3}(x^3)^{2/3} = 36x^2$$

$$69. \quad \frac{p^{a/2}p^{a/3}}{p^{a/6}} = \frac{p^{3a/6}p^{2a/6}}{p^{a/6}} = \frac{p^{5a/6}}{p^{a/6}} = p^{4a/6} = p^{2a/3}$$

$$70. \quad \sqrt{36} = 6$$

$$71. \quad -\sqrt{49} = -7$$

$$72. \quad \sqrt{\frac{9}{25}} = \frac{\sqrt{9}}{\sqrt{25}} = \frac{3}{5}$$

$$73. \quad \sqrt[3]{\frac{27}{125}} = \frac{\sqrt[3]{27}}{\sqrt[3]{125}} = \frac{3}{5}$$

$$74. \quad \sqrt{x^2y^4} = \sqrt{x^2}\sqrt{y^4} \\ = |x|y^2$$

$$75. \quad \sqrt[3]{x^3} = x$$

$$76. \quad \sqrt[4]{\frac{m^8n^4}{p^{16}}} = \frac{\sqrt[4]{m^8}\sqrt[4]{n^4}}{\sqrt[4]{p^{16}}} = \frac{m^2|n|}{p^4}$$

$$77. \quad \sqrt[5]{\frac{a^{15}b^{10}}{c^5}} = \frac{\sqrt[5]{a^{15}}\sqrt[5]{b^{10}}}{\sqrt[5]{c^5}} = \frac{a^3b^2}{c}$$

$$78. \quad \sqrt{50} + \sqrt{8} = \sqrt{25}\sqrt{2} + \sqrt{4}\sqrt{2} = 5\sqrt{2} + 2\sqrt{2} = 7\sqrt{2}$$

$$79. \quad \sqrt{12} + \sqrt{3} - \sqrt{27} = \sqrt{4}\sqrt{3} + \sqrt{3} - \sqrt{9}\sqrt{3} = 2\sqrt{3} + \sqrt{3} - 3\sqrt{3} = 3\sqrt{3} - 3\sqrt{3} = 0$$

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$$80. \sqrt[3]{24x^4} - \sqrt[3]{3x^4} = \sqrt[3]{8x^3} \sqrt[3]{3x} - \sqrt[3]{x^3} \sqrt[3]{3x} = 2x \sqrt[3]{3x} - x \sqrt[3]{3x} = x \sqrt[3]{3x}$$

$$81. \frac{\sqrt{7}}{\sqrt{5}} = \frac{\sqrt{7}}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{\sqrt{35}}{5}$$

$$82. \frac{8}{\sqrt{8}} = \frac{8}{\sqrt{8}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{8\sqrt{2}}{\sqrt{16}} = \frac{8\sqrt{2}}{4} = 2\sqrt{2}$$

$$83. \frac{1}{\sqrt[3]{2}} = \frac{1}{\sqrt[3]{2}} \cdot \frac{\sqrt[3]{4}}{\sqrt[3]{4}} = \frac{\sqrt[3]{4}}{\sqrt[3]{8}} = \frac{\sqrt[3]{4}}{2}$$

$$84. \frac{2}{\sqrt[3]{25}} = \frac{2}{\sqrt[3]{25}} \cdot \frac{\sqrt[3]{5}}{\sqrt[3]{5}} = \frac{2\sqrt[3]{5}}{\sqrt[3]{125}} = \frac{2\sqrt[3]{5}}{5}$$

$$85. \frac{\sqrt{2}}{5} = \frac{\sqrt{2}}{5} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{2}{5\sqrt{2}}$$

$$86. \frac{\sqrt{5}}{5} = \frac{\sqrt{5}}{5} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{5}{5\sqrt{5}} = \frac{1}{\sqrt{5}}$$

$$87. \frac{\sqrt{2x}}{3} = \frac{\sqrt{2x}}{3} \cdot \frac{\sqrt{2x}}{\sqrt{2x}} = \frac{2x}{3\sqrt{2x}}$$

$$88. \frac{3\sqrt[3]{7x}}{2} = \frac{3\sqrt[3]{7x}}{2} \cdot \frac{\sqrt[3]{49x^2}}{\sqrt[3]{49x^2}} = \frac{3\sqrt[3]{343x^3}}{2\sqrt[3]{49x^2}} = \frac{21x}{2\sqrt[3]{49x^2}}$$

89. 3rd degree, binomial

90. 2nd degree, trinomial

91. 2nd degree, monomial

92. 4th degree, trinomial

$$93. 2(x+3) + 3(x-4) = 2x + 6 + 3x - 12 = 5x - 6$$

$$94. 3x^2(x-1) - 2x(x+3) - x^2(x+2) = 3x^3 - 3x^2 - 2x^2 - 6x - x^3 - 2x^2 = 2x^3 - 7x^2 - 6x$$

$$95. (3x+2)(3x+2) = 9x^2 + 6x + 6x + 4 = 9x^2 + 12x + 4$$

$$96. (3x+y)(2x-3y) = 6x^2 - 9xy + 2xy - 3y^2 = 6x^2 - 7xy - 3y^2$$

$$97. (4a+2b)(2a-3b) = 8a^2 - 12ab + 4ab - 6b^2 = 8a^2 - 8ab - 6b^2$$

$$98. (z+3)(3z^2+z-1) = 3z^3 + z^2 - z + 9z^2 + 3z - 3 = 3z^3 + 10z^2 + 2z - 3$$

$$99. (a^n+2)(a^n-1) = a^{2n} - a^n + 2a^n - 2 = a^{2n} + a^n - 2$$

$$100. (\sqrt{2}+x)^2 = (\sqrt{2}+x)(\sqrt{2}+x) = (\sqrt{2})^2 + x\sqrt{2} + x\sqrt{2} + x^2 = 2 + 2x\sqrt{2} + x^2$$

$$101. (\sqrt{2}+1)(\sqrt{3}+1) = \sqrt{6} + \sqrt{2} + \sqrt{3} + 1$$

$$102. (\sqrt[3]{3}-2)(\sqrt[3]{9}+2\sqrt[3]{3}+4) = \sqrt[3]{27} + 2\sqrt[3]{9} + 4\sqrt[3]{3} - 2\sqrt[3]{9} - 4\sqrt[3]{3} - 8 = 3 - 8 = -5$$

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$$103. \frac{2}{\sqrt{3}-1} = \frac{2}{\sqrt{3}-1} \cdot \frac{\sqrt{3}+1}{\sqrt{3}+1} = \frac{2(\sqrt{3}+1)}{(\sqrt{3})^2-1^2} = \frac{2(\sqrt{3}+1)}{3-1} = \frac{2(\sqrt{3}+1)}{2} = \sqrt{3}+1$$

$$104. \frac{-2}{\sqrt{3}-\sqrt{2}} = \frac{-2}{\sqrt{3}-\sqrt{2}} \cdot \frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}+\sqrt{2}} = \frac{-2(\sqrt{3}+\sqrt{2})}{(\sqrt{3})^2-(\sqrt{2})^2} = \frac{-2(\sqrt{3}+\sqrt{2})}{3-2}$$

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

$$= -2(\sqrt{3}+\sqrt{2})$$

$$105. \frac{2x}{\sqrt{x}-2} = \frac{2x}{\sqrt{x}-2} \cdot \frac{\sqrt{x}+2}{\sqrt{x}+2} = \frac{2x(\sqrt{x}+2)}{(\sqrt{x})^2-2^2} = \frac{2x(\sqrt{x}+2)}{x-4}$$

$$106. \frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}+\sqrt{y}} = \frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}+\sqrt{y}} \cdot \frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}-\sqrt{y}} = \frac{\sqrt{x^2}-\sqrt{xy}-\sqrt{xy}+y}{(\sqrt{x})^2-(\sqrt{y})^2} = \frac{x-2\sqrt{xy}+y}{x-y}$$

$$107. \frac{\sqrt{x}+2}{5} = \frac{\sqrt{x}+2}{5} \cdot \frac{\sqrt{x}-2}{\sqrt{x}-2} = \frac{(\sqrt{x})^2-2^2}{5(\sqrt{x}-2)} = \frac{x-4}{5(\sqrt{x}-2)}$$

$$108. \frac{1-\sqrt{a}}{a} = \frac{1-\sqrt{a}}{a} \cdot \frac{1+\sqrt{a}}{1+\sqrt{a}} = \frac{1^2-(\sqrt{a})^2}{a(1+\sqrt{a})} = \frac{1-a}{a(1+\sqrt{a})}$$

$$109. \frac{3x^2y^2}{6x^3y} = \frac{y}{2x}$$

$$110. \frac{4a^2b^3+6ab^4}{2b^2} = \frac{4a^2b^3}{2b^2} + \frac{6ab^4}{2b^2}$$

$$= 2a^2b + 3ab^2$$

$$111. \begin{array}{r} 2x+3 \overline{) \frac{x^2+2x+1}{2x^3+7x^2+8x+3}} \\ \underline{2x^3+3x^2} \\ 4x^2+8x \\ \underline{4x^2+6x} \\ 2x+3 \\ \underline{2x+3} \\ 0 \end{array}$$

$$112. \begin{array}{r} x^3+2x-3+\frac{-6}{x^2-1} \\ x^2-1 \overline{) \frac{x^3+0x^2+x^3-3x^2-2x-3}{x^5-0x^4+x^3-3x^2-2x-3}} \\ \underline{x^3-3x^2-2x-3} \\ 2x^3-3x^2-2x-3 \\ \underline{2x^3-2x} \\ -3x^2-3 \\ \underline{-3x^2+3} \\ -6 \end{array}$$

$$113. 3t^3 - 3t = 3t(t^2 - 1) = 3t(t+1)(t-1)$$

$$114. 5r^3 - 5 = 5(r^3 - 1) = 5(r^3 - 1^3) = 5(r-1)(r^2+r+1)$$

$$115. 6x^2 + 7x - 24 = (3x+8)(2x-3)$$

$$116. 3a^2 + ax - 3a - x = a(3a+x) - 1(3a+x) = (3a+x)(a-1)$$

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117. $8x^3 - 125 = (2x)^3 - 5^3 = (2x - 5)[(2x)^2 + (2x)(5) + 5^2] = (2x - 5)(4x^2 + 10x + 25)$

118. $6x^2 - 20x - 16 = 2(3x^2 - 10x - 8) = 2(3x + 2)(x - 4)$

119. $x^2 + 6x + 9 - t^2 = (x + 3)(x + 3) - t^2 = (x + 3)^2 - t^2 = (x + 3 + t)(x + 3 - t)$

120. $3x^2 - 1 + 5x = 3x^2 + 5x - 1 \Rightarrow$ **prime**

121. $8z^3 + 343 = (2z)^3 + 7^3 = (2z + 7)[(2z)^2 - (2z)(7) + 7^2] = (2z + 7)(4z^2 - 14z + 49)$

122. $1 + 14b + 49b^2 = 49b^2 + 14b + 1 = (7b + 1)(7b + 1) = (7b + 1)^2$

123. $121z^2 + 4 - 44z = 121z^2 - 44z + 4 = (11z - 2)(11z - 2) = (11z - 2)^2$

124. $64y^3 - 1,000 = 8(8y^3 - 125) = 8[(2y)^3 - 5^3] = 8(2y - 5)(4y^2 + 10y + 25)$

125. $2xy - 4zx - wy + 2zw = 2x(y - 2z) - w(y - 2z) = (y - 2z)(2x - w)$

126.
$$\begin{aligned} x^8 + x^4 + 1 &= x^8 + 2x^4 + 1 - x^4 = (x^4 + 1)(x^4 + 1) - x^4 \\ &= (x^4 + 1)^2 - (x^2)^2 \\ &= (x^4 + 1 + x^2)(x^4 + 1 - x^2) \\ &= (x^4 + 2x^2 + 1 - x^2)(x^4 - x^2 + 1) \\ &= [(x^2 + 1)(x^2 + 1) - x^2](x^4 - x^2 + 1) \\ &= (x^2 + 1 + x)(x^2 + 1 - x)(x^4 - x^2 + 1) \end{aligned}$$

127. $\frac{2-x}{x^2-4x+4} = \frac{-(x-2)}{(x-2)(x-2)} = \frac{-1}{x-2}$ **128.** $\frac{a^2-9}{a^2-6a+9} = \frac{(a+3)(a-3)}{(a-3)(a-3)} = \frac{a+3}{a-3}$

129. $\frac{x^2-4x+4}{x+2} \cdot \frac{x^2+5x+6}{x-2} = \frac{(x-2)(x-2)}{x+2} \cdot \frac{(x+2)(x+3)}{x-2} = (x-2)(x+3)$

130. $\frac{2y^2-11y+15}{y^2-6y+8} \cdot \frac{y^2-2y-8}{y^2-y-6} = \frac{(2y-5)(y-3)}{(y-4)(y-2)} \cdot \frac{(y-4)(y+2)}{(y-3)(y+2)} = \frac{2y-5}{y-2}$

131.
$$\begin{aligned} \frac{2t^2+t-3}{3t^2-7t+4} \div \frac{10t+15}{3t^2-t-4} &= \frac{2t^2+t-3}{3t^2-7t+4} \cdot \frac{3t^2-t-4}{10t+15} \\ &= \frac{(2t+3)(t-1)}{(3t-4)(t-1)} \cdot \frac{(3t-4)(t+1)}{5(2t+3)} = \frac{t+1}{5} \end{aligned}$$

132.
$$\begin{aligned} \frac{p^2+7p+12}{p^3+8p^2+4p} \div \frac{p^2-9}{p^2} &= \frac{p^2+7p+12}{p^3+8p^2+4p} \cdot \frac{p^2}{p^2-9} = \frac{(p+3)(p+4)}{p(p^2+8p+4)} \cdot \frac{p^2}{(p+3)(p-3)} \\ &= \frac{p(p+4)}{(p^2+8p+4)(p-3)} \end{aligned}$$

CHAPTER 0 REVIEW

$$\begin{aligned}
 133. \quad & \frac{x^2 + x - 6}{x^2 - x - 6} \cdot \frac{x^2 - x - 6}{x^2 + x - 2} \div \frac{x^2 - 4}{x^2 - 5x + 6} \\
 &= \frac{x^2 + x - 6}{x^2 - x - 6} \cdot \frac{x^2 - x - 6}{x^2 + x - 2} \cdot \frac{x^2 - 5x + 6}{x^2 - 4} \\
 &= \frac{(x+3)(x-2)}{(x-3)(x+2)} \cdot \frac{(x-3)(x+2)}{(x+2)(x-1)} \cdot \frac{(x-2)(x-3)}{(x+2)(x-2)} = \frac{(x+3)(x-2)(x-3)}{(x+2)^2(x-1)}
 \end{aligned}$$

$$\begin{aligned}
 134. \quad & \left(\frac{2x+6}{x+5} \div \frac{2x^2-2x-4}{x^2-25} \right) \frac{x^2-x-2}{x^2-2x-15} = \frac{2x+6}{x+5} \cdot \frac{x^2-25}{2(x^2-x-2)} \cdot \frac{x^2-x-2}{x^2-2x-15} \\
 &= \frac{2(x+3)}{x+5} \cdot \frac{(x+5)(x-5)}{2(x-2)(x+1)} \cdot \frac{(x-2)(x+1)}{(x-5)(x+3)} = 1
 \end{aligned}$$

$$\begin{aligned}
 135. \quad & \frac{2}{x-4} + \frac{3x}{x+5} = \frac{2(x+5)}{(x-4)(x+5)} + \frac{3x(x-4)}{(x+5)(x-4)} = \frac{2x+10}{(x-4)(x+5)} + \frac{3x^2-12x}{(x-4)(x+5)} \\
 &= \frac{3x^2-10x+10}{(x-4)(x+5)}
 \end{aligned}$$

$$\begin{aligned}
 136. \quad & \frac{5x}{x-2} - \frac{3x+7}{x+2} + \frac{2x+1}{x+2} = \frac{5x}{x-2} + \frac{-x-6}{x+2} = \frac{5x(x+2)}{(x-2)(x+2)} + \frac{(-x-6)(x-2)}{(x+2)(x-2)} \\
 &= \frac{5x^2+10x}{(x-2)(x+2)} + \frac{-x^2-4x+12}{(x-2)(x+2)} \\
 &= \frac{4x^2+6x+12}{(x-2)(x+2)} = \frac{2(2x^2+3x+6)}{(x-2)(x+2)}
 \end{aligned}$$

$$\begin{aligned}
 137. \quad & \frac{x}{x-1} + \frac{x}{x-2} + \frac{x}{x-3} \\
 &= \frac{x(x-2)(x-3)}{(x-1)(x-2)(x-3)} + \frac{x(x-1)(x-3)}{(x-2)(x-1)(x-3)} + \frac{x(x-1)(x-2)}{(x-3)(x-1)(x-2)} \\
 &= \frac{x^3-5x^2+6x}{(x-1)(x-2)(x-3)} + \frac{x^3-4x^2+3x}{(x-1)(x-2)(x-3)} + \frac{x^3-3x^2+2x}{(x-1)(x-2)(x-3)} \\
 &= \frac{3x^3-12x^2+11x}{(x-1)(x-2)(x-3)} = \frac{x(3x^2-12x+11)}{(x-1)(x-2)(x-3)}
 \end{aligned}$$

$$\begin{aligned}
 138. \quad & \frac{x}{x+1} - \frac{3x+7}{x+2} + \frac{2x+1}{x+2} = \frac{x}{x+1} + \frac{-3x-7}{x+2} + \frac{2x+1}{x+2} \\
 &= \frac{x}{x+1} + \frac{-x-6}{x+2} \\
 &= \frac{x(x+2)}{(x+1)(x+2)} + \frac{(-x-6)(x+1)}{(x+2)(x+1)} \\
 &= \frac{x^2+2x}{(x+1)(x+2)} + \frac{-x^2-7x-6}{(x+1)(x+2)} = \frac{-5x-6}{(x+1)(x+2)}
 \end{aligned}$$

CHAPTER 0 REVIEW

$$\begin{aligned}
 139. \quad \frac{3(x+1)}{x} - \frac{5(x^2+3)}{x^2} + \frac{x}{x+1} &= \frac{3x(x+1)(x+1)}{x^2(x+1)} - \frac{5(x^2+3)(x+1)}{x^2(x+1)} + \frac{x(x^2)}{x^2(x+1)} \\
 &= \frac{3x^3+6x^2+3x}{x^2(x+1)} - \frac{5x^3+5x^2+15x+15}{x^2(x+1)} + \frac{x^3}{x^2(x+1)} \\
 &= \frac{-x^3+x^2-12x-15}{x^2(x+1)}
 \end{aligned}$$

$$\begin{aligned}
 140. \quad \frac{3x}{x+1} + \frac{x^2+4x+3}{x^2+3x+2} - \frac{x^2+x-6}{x^2-4} &= \frac{3x}{x+1} + \frac{(x+3)(x+1)}{(x+1)(x+2)} - \frac{(x+3)(x-2)}{(x+2)(x-2)} \\
 &= \frac{3x}{x+1} + \frac{x+3}{x+2} - \frac{x+3}{x+2} = \frac{3x}{x+1}
 \end{aligned}$$

$$141. \quad \frac{\frac{5x}{2}}{\frac{3x^2}{8}} = \frac{5x}{2} \div \frac{3x^2}{8} = \frac{5x}{2} \cdot \frac{8}{3x^2} = \frac{20}{3x}$$

$$142. \quad \frac{\frac{3x}{y}}{\frac{6x}{y^2}} = \frac{3x}{y} \div \frac{6x}{y^2} = \frac{3x}{y} \cdot \frac{y^2}{6x} = \frac{y}{2}$$

$$143. \quad \frac{\frac{1}{x} + \frac{1}{y}}{x-y} = \frac{xy\left(\frac{1}{x} + \frac{1}{y}\right)}{xy(x-y)} = \frac{xy\left(\frac{1}{x}\right) + xy\left(\frac{1}{y}\right)}{xy(x-y)} = \frac{y+x}{xy(x-y)}$$

$$144. \quad \frac{x^{-1} + y^{-1}}{y^{-1} - x^{-1}} = \frac{\frac{1}{x} + \frac{1}{y}}{\frac{1}{y} - \frac{1}{x}} = \frac{xy\left(\frac{1}{x} + \frac{1}{y}\right)}{xy\left(\frac{1}{y} - \frac{1}{x}\right)} = \frac{xy\left(\frac{1}{x}\right) + xy\left(\frac{1}{y}\right)}{xy\left(\frac{1}{y}\right) - xy\left(\frac{1}{x}\right)} = \frac{y+x}{x-y}$$

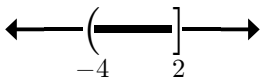
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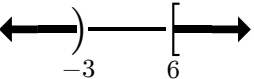
1. odd integers: $-7, 1, 3$

2. prime numbers: 3

3. commutative property of addition

4. distributive property

5. $-4 < x \leq 2 \Rightarrow$ 

6. $(-\infty, -3) \cup [6, \infty) \Rightarrow$ 

7. Since $-17 < 0$, $|-17| = -(-17) = 17$

8. If $x < 0$, then $x - 7 < 0$. Then $|x - 7| = -(x - 7)$.

9. distance = $|12 - (-4)| = |16| = 16$

10. distance = $|-12 - (-20)| = |8| = 8$

11. $x^4 x^5 x^2 = x^{4+5+2} = x^{11}$

12. $\frac{r^2 r^3 s}{r^4 s^2} = \frac{r^5 s}{r^4 s^2} = \frac{r}{s}$

13. $\frac{(a^{-1} a^2)^{-2}}{a^{-3}} = \frac{(a^1)^{-2}}{a^{-3}} = \frac{a^{-2}}{a^{-3}} = a$

14. $\left(\frac{x^0 x^2}{x^{-2}}\right)^6 = \left(\frac{x^2}{x^{-2}}\right)^6 = (x^4)^6 = x^{24}$

15. $450,000 = 4.5 \times 10^5$

16. $0.000345 = 3.45 \times 10^{-4}$

CHAPTER 0 TEST

17. $3.7 \times 10^3 = 3,700$

18. $1.2 \times 10^{-3} = 0.0012$

19. $(25a^4)^{1/2} = 25^{1/2}(a^4)^{1/2} = 5a^2$

20. $\left(\frac{36}{81}\right)^{3/2} = \frac{36^{3/2}}{81^{3/2}} = \frac{(36^{1/2})^3}{(81^{1/2})^3} = \frac{216}{729}$

21. $\left(\frac{8t^6}{27s^9}\right)^{-2/3} = \left(\frac{27s^9}{8t^6}\right)^{2/3} = \frac{27^{2/3}(s^9)^{2/3}}{8^{2/3}(t^6)^{2/3}} = \frac{(27^{1/3})^2 s^6}{(8^{1/3})^2 t^4} = \frac{9s^6}{4t^4}$

22. $\sqrt[3]{27a^6} = \sqrt[3]{27}\sqrt[3]{a^6} = 3a^2$

23. $\sqrt{12} + \sqrt{27} = \sqrt{4}\sqrt{3} + \sqrt{9}\sqrt{3}$
 $= 2\sqrt{3} + 3\sqrt{3} = 5\sqrt{3}$

24. $2\sqrt[3]{3x^4} - 3x\sqrt[3]{24x} = 2\sqrt[3]{x^3}\sqrt[3]{3x} - 3x\sqrt[3]{8}\sqrt[3]{3x} = 2x\sqrt[3]{3x} - 3x(2)\sqrt[3]{3x} = 2x\sqrt[3]{3x} - 6x\sqrt[3]{3x}$
 $= -4x\sqrt[3]{3x}$

25. $\frac{x}{\sqrt{x}-2} = \frac{x}{\sqrt{x}-2} \cdot \frac{\sqrt{x}+2}{\sqrt{x}+2} = \frac{x(\sqrt{x}+2)}{(\sqrt{x})^2-2^2} = \frac{x(\sqrt{x}+2)}{x-4}$

26. $\frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}+\sqrt{y}} = \frac{\sqrt{x}-\sqrt{y}}{\sqrt{x}+\sqrt{y}} \cdot \frac{\sqrt{x}+\sqrt{y}}{\sqrt{x}+\sqrt{y}} = \frac{(\sqrt{x})^2 - (\sqrt{y})^2}{\sqrt{x^2} + \sqrt{xy} + \sqrt{xy} + \sqrt{y^2}} = \frac{x-y}{x+2\sqrt{xy}+y}$

27. $(a^2+3) - (2a^2-4) = a^2+3-2a^2+4$
 $= -a^2+7$

28. $(3a^3b^2)(-2a^3b^4) = -6a^6b^6$

29. $(3x-4)(2x+7) = 6x^2+21x-8x-28$
 $= 6x^2+13x-28$

30. $(a^n+2)(a^n-3) = a^{2n}-3a^n+2a^n-6$
 $= a^{2n}-a^n-6$

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

32. $(x^2-x+2)(2x-3) = 2x^3-3x^2-2x^2+3x+4x-6 = 2x^3-5x^2+7x-6$

33.
$$\begin{array}{r} 6x + 19 + \frac{34}{x-3} \\ x-3 \overline{) 6x^2 + x - 23} \\ \underline{6x^2 - 18x} \\ 19x - 23 \\ \underline{19x - 57} \\ 34 \end{array}$$

34.
$$\begin{array}{r} x^2 + 2x + 1 \\ 2x-1 \overline{) 2x^3 + 3x^2 + 0x - 1} \\ \underline{2x^3 - x^2} \\ 4x^2 + 0x \\ \underline{4x^2 - 2x} \\ 2x - 1 \\ \underline{2x - 1} \\ 0 \end{array}$$

35. $3x+6y = 3(x+2y)$

36. $x^2-100 = x^2-10^2 = (x+10)(x-10)$

37. $10t^2-19tw+6w^2 = (5t-2w)(2t-3w)$

38. $3a^3-648 = 3(a^3-216)$
 $= 3(a-6)(a^2+6a+36)$

SECTION 1.1

39. $x^4 - x^2 - 12 = (x^2 - 4)(x^2 + 3)$
 $= (x + 2)(x - 2)(x^2 + 3)$
40. $6x^4 + 11x^2 - 10 = (3x^2 - 2)(2x^2 + 5)$
41. $\frac{x}{x+2} + \frac{2}{x+2} = \frac{x+2}{x+2} = 1$
42. $\frac{x}{x+1} - \frac{x}{x-1} = \frac{x(x-1)}{(x+1)(x-1)} - \frac{x(x+1)}{(x+1)(x-1)} = \frac{x^2 - x - x^2 - x}{(x+1)(x-1)} = \frac{-2x}{(x+1)(x-1)}$
43. $\frac{x^2 + x - 20}{x^2 - 16} \cdot \frac{x^2 - 25}{x - 5} = \frac{(x+5)(x-4)}{(x+4)(x-4)} \cdot \frac{(x+5)(x-5)}{x-5} = \frac{(x+5)^2}{x+4}$
44. $\frac{x+2}{x^2+2x+1} \div \frac{x^2-4}{x+1} = \frac{x+2}{(x+1)(x+1)} \cdot \frac{x+1}{(x+2)(x-2)} = \frac{1}{(x+1)(x-2)}$
45. $\frac{\frac{1}{a} + \frac{1}{b}}{\frac{1}{b}} = \frac{ab(\frac{1}{a} + \frac{1}{b})}{ab(\frac{1}{b})} = \frac{ab(\frac{1}{a}) + ab(\frac{1}{b})}{a} = \frac{b+a}{a}$
46. $\frac{x^{-1}}{x^{-1} + y^{-1}} = \frac{\frac{1}{x}}{\frac{1}{x} + \frac{1}{y}} = \frac{xy(\frac{1}{x})}{xy(\frac{1}{x} + \frac{1}{y})} = \frac{y}{xy(\frac{1}{x}) + xy(\frac{1}{y})} = \frac{y}{y+x}$

Exercises 1.1 (page 93)

- | | | | |
|---|--|--|---|
| 1. root, solution | 2. identity | 3. no | 4. conditional |
| 5. linear | 6. rational | 7. one | 8. denominator |
| 9. $x + 3 = 1$
no restrictions | 10. $\frac{1}{2}x - 7 = 14$
no restrictions | 11. $\frac{1}{x} = 12$
$x \neq 0$ | 12. $\frac{3}{x-2} = 9x$
$x \neq 2$ |
| 13. $\frac{8}{x-3} = \frac{5}{x+2}$
$x-3 \neq 0$ $x+2 \neq 0$
$x \neq 3$ $x \neq -2$
$x \neq 3, x \neq -2$ | 14. $\frac{x}{x-3} = -\frac{4}{x+4}$
$x-3 \neq 0$ $x+4 \neq 0$
$x \neq 3$ $x \neq -4$
$x \neq 3, x \neq -4$ | 15. $\frac{1}{x-3} = \frac{5x}{x^2-16}$
$\frac{1}{x-3} = \frac{5x}{(x+4)(x-4)}$
$x-3 \neq 0$ $x+4 \neq 0$ $x-4 \neq 0$
$x \neq 3$ $x \neq -4$ $x \neq 4$
$x \neq 3, x \neq -4, x \neq 4$ | 16. $\frac{1}{x^2-3x-4} = \frac{5}{x} + 2$
$\frac{1}{(x+1)(x-4)} = \frac{5}{x} + 2$
$x+1 \neq 0$ $x-4 \neq 0$ $x \neq 0$
$x \neq -1$ $x \neq 4$
$x \neq -1, x \neq 4, x \neq 0$ |

SECTION 1.1

17. $2x + 5 = 15$
 $2x + 5 - 5 = 15 - 5$
 $2x = 10$
 $\frac{2x}{2} = \frac{10}{2}$
 $x = 5$
 conditional equation

18. $3x + 2 = x + 8$
 $3x - x + 2 = x - x + 8$
 $2x + 2 = 8$
 $2x + 2 - 2 = 8 - 2$
 $2x = 6$
 $\frac{2x}{2} = \frac{6}{2}$
 $x = 3$
 conditional equation

19. $2(n + 2) - 5 = 2n$
 $2n + 4 - 5 = 2n$
 $2n - 1 = 2n$
 $2n - 2n - 1 = 2n - 2n$
 $-1 \neq 0$
 contradiction

20. $3(m + 2) = 2(m + 3) + m$
 $3m + 6 = 2m + 6 + m$
 $3m + 6 = 3m + 6$
 identity

21. $\frac{x + 7}{2} = 7$
 $2 \cdot \frac{x + 7}{2} = 2(7)$
 $x + 7 = 14$
 $x + 7 - 7 = 14 - 7$
 $x = 7$
 conditional equation

22. $\frac{x}{2} - 7 = 14$
 $\frac{x}{2} - 7 + 7 = 14 + 7$
 $\frac{x}{2} = 21$
 $2 \cdot \frac{x}{2} = 2(21)$
 $x = 42$
 conditional equation

23. $2(a + 1) = 3(a - 2) - a$
 $2a + 2 = 3a - 6 - a$
 $2a + 2 = 2a - 6$
 $2a - 2a + 2 = 2a - 2a - 6$
 $2 \neq -6$
 contradiction

24. $x^2 = (x + 4)(x - 4) + 16$
 $x^2 = x^2 - 16 + 16$
 $x^2 = x^2$
 identity

25. $3(x - 3) = \frac{6x - 18}{2}$
 $3x - 9 = \frac{6x - 18}{2}$
 $2(3x - 9) = 2 \cdot \frac{6x - 18}{2}$
 $6x - 18 = 6x - 18$
 identity

26. $x(x + 2) = (x + 1)^2$
 $x^2 + 2x = (x + 1)(x + 1)$
 $x^2 + 2x = x^2 + 2x + 1$
 $x^2 - x^2 + 2x = x^2 - x^2 + 2x + 1$
 $2x = 2x + 1$
 $2x - 2x = 2x - 2x + 1$
 $0 \neq 1$
 contradiction

SECTION 1.1

$$\begin{aligned}
 27. \quad & \frac{3}{b-3} = 1 \\
 & (b-3) \cdot \frac{3}{b-3} = (b-3)(1) \\
 & \quad 3 = b-3 \\
 & \quad 3+3 = b-3+3 \\
 & \quad 6 = b \\
 & \text{conditional equation}
 \end{aligned}$$

$$\begin{aligned}
 29. \quad & 2x^2 + 5x - 3 = (2x-1)(x+3) \\
 & 2x^2 + 5x - 3 = 2x^2 + 5x - 3 \\
 & \quad \text{identity}
 \end{aligned}$$

$$\begin{aligned}
 31. \quad & 2x + 7 = 10 - x \\
 & 3x + 7 = 10 \\
 & \quad 3x = 3 \\
 & \quad x = 1
 \end{aligned}$$

$$\begin{aligned}
 33. \quad & 5(x-2) = 2(x+4) \\
 & 5x - 10 = 2x + 8 \\
 & 3x - 10 = 8 \\
 & \quad 3x = 18 \\
 & \quad x = 6
 \end{aligned}$$

$$\begin{aligned}
 35. \quad & 7(2x+5) - 6(x+8) = 7 \\
 & 14x + 35 - 6x - 48 = 7 \\
 & \quad 8x - 13 = 7 \\
 & \quad 8x = 20 \\
 & \quad x = \frac{20}{8} = \frac{5}{2}
 \end{aligned}$$

$$\begin{aligned}
 28. \quad & x^2 - 8x + 15 = (x-3)(x+5) \\
 & x^2 - 8x + 15 = x^2 + 2x - 15 \\
 & x^2 - x^2 - 8x + 15 = x^2 - x^2 + 2x - 15 \\
 & \quad -8x + 15 = 2x - 15 \\
 & \quad -8x + 8x + 15 = 2x + 8x - 15 \\
 & \quad 15 = 10x - 15 \\
 & \quad 15 + 15 = 10x - 15 + 15 \\
 & \quad 30 = 10x \\
 & \quad \frac{30}{10} = \frac{10x}{10} \\
 & \quad 3 = x \\
 & \text{conditional equation}
 \end{aligned}$$

$$\begin{aligned}
 30. \quad & 2x^2 + 5x - 3 = 2x \left(x + \frac{19}{2} \right) \\
 & 2x^2 + 5x - 3 = 2x^2 + 19x \\
 & 2x^2 - 2x^2 + 5x - 3 = 2x^2 - 2x^2 + 19x \\
 & \quad 5x - 3 = 19x \\
 & \quad 5x - 5x - 3 = 19x - 5x \\
 & \quad -3 = 14x \\
 & \quad \frac{-3}{14} = \frac{14x}{14} \\
 & \quad -\frac{3}{14} = x \\
 & \text{conditional equation}
 \end{aligned}$$

$$\begin{aligned}
 32. \quad & 9a - 3 = 15 + 3a \\
 & 6a - 3 = 15 \\
 & \quad 6a = 18 \\
 & \quad a = 3
 \end{aligned}$$

$$\begin{aligned}
 34. \quad & 5(r-4) = -5(r-4) \\
 & 5r - 20 = -5r + 20 \\
 & 10r - 20 = 20 \\
 & \quad 10r = 40 \\
 & \quad r = 4
 \end{aligned}$$

$$\begin{aligned}
 36. \quad & 6(x-5) - 4(x+2) = -1 \\
 & 6x - 30 - 4x - 8 = -1 \\
 & \quad 2x - 38 = -1 \\
 & \quad 2x = 37 \\
 & \quad x = \frac{37}{2}
 \end{aligned}$$

SECTION 1.1

$$37. \quad \frac{5}{3}z - 8 = 7$$

$$\frac{5}{3}z = 15$$

$$3 \cdot \frac{5}{3}z = 3(15)$$

$$5z = 45$$

$$z = 9$$

$$38. \quad \frac{4}{3}y + 12 = -4$$

$$\frac{4}{3}y = -16$$

$$3 \cdot \frac{4}{3}y = 3(-16)$$

$$4y = -48$$

$$y = -12$$

$$39. \quad \frac{z}{5} + 2 = 4$$

$$\frac{z}{5} = 2$$

$$5 \cdot \frac{z}{5} = 5(2)$$

$$z = 10$$

$$40. \quad \frac{3p}{7} - p = -4$$

$$7\left(\frac{3p}{7} - p\right) = 7(-4)$$

$$3p - 7p = -28$$

$$-4p = -28$$

$$p = 7$$

$$41. \quad \frac{3x - 2}{3} = 2x + \frac{7}{3}$$

$$3 \cdot \frac{3x - 2}{3} = 3\left(2x + \frac{7}{3}\right)$$

$$3x - 2 = 6x + 7$$

$$-3x - 2 = 7$$

$$-3x = 9$$

$$x = -3$$

$$42. \quad \frac{7}{2}x + 5 = x + \frac{15}{2}$$

$$2\left(\frac{7}{2}x + 5\right) = 2\left(x + \frac{15}{2}\right)$$

$$7x + 10 = 2x + 15$$

$$5x + 10 = 15$$

$$5x = 5$$

$$x = 1$$

$$43. \quad \frac{3x + 1}{20} = \frac{1}{2}$$

$$20 \cdot \frac{3x + 1}{20} = 20 \cdot \frac{1}{2}$$

$$3x + 1 = 10$$

$$3x = 9$$

$$x = 3$$

$$44. \quad 2x - \frac{7}{6} + \frac{x}{6} = \frac{4x + 3}{6}$$

$$6\left(2x - \frac{7}{6} + \frac{x}{6}\right) = 6 \cdot \frac{4x + 3}{6}$$

$$12x - 7 + x = 4x + 3$$

$$13x - 7 = 4x + 3$$

$$9x - 7 = 3$$

$$9x = 10$$

$$x = \frac{10}{9}$$

$$45. \quad \frac{3 + x}{3} + \frac{x + 7}{2} = 4x + 1$$

$$6\left(\frac{3 + x}{3} + \frac{x + 7}{2}\right) = 6(4x + 1)$$

$$2(3 + x) + 3(x + 7) = 24x + 6$$

$$6 + 2x + 3x + 21 = 24x + 6$$

$$5x + 27 = 24x + 6$$

$$-19x + 27 = 6$$

$$-19x = -21$$

$$x = \frac{21}{19}$$

$$46. \quad 2(2x + 1) - \frac{3x}{2} = \frac{-3(4 + x)}{2}$$

$$2\left[2(2x + 1) - \frac{3x}{2}\right] = 2 \cdot \frac{-3(4 + x)}{2}$$

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

$$8x + 4 - 3x = -12 - 3x$$

$$5x + 4 = -12 - 3x$$

$$8x + 4 = -12$$

$$8x = -16$$

$$x = -2$$

SECTION 1.1

$$\begin{aligned}
 47. \quad & \frac{3}{2}(3x-2) - 10x - 4 = 0 \\
 & 2\left[\frac{3}{2}(3x-2) - 10x - 4\right] = 2(0) \\
 & 3(3x-2) - 20x - 8 = 0 \\
 & 9x - 6 - 20x - 8 = 0 \\
 & -11x - 14 = 0 \\
 & -11x = 14 \\
 & x = -\frac{14}{11}
 \end{aligned}$$

$$\begin{aligned}
 49. \quad & \frac{(y+2)^2}{3} = y + 2 + \frac{y^2}{3} \\
 & 3\left[\frac{(y+2)^2}{3}\right] = 3\left(y + 2 + \frac{y^2}{3}\right) \\
 & (y+2)^2 = 3y + 6 + y^2 \\
 & y^2 + 4y + 4 = y^2 + 3y + 6 \\
 & 4y + 4 = 3y + 6 \\
 & y + 4 = 6 \\
 & y = 2
 \end{aligned}$$

$$\begin{aligned}
 51. \quad & x(x+2) = (x+1)^2 - 1 \\
 & x^2 + 2x = (x+1)(x+1) - 1 \\
 & x^2 + 2x = x^2 + 2x + 1 - 1 \\
 & x^2 + 2x = x^2 + 2x \\
 & 0 = 0 \Rightarrow \text{identity}
 \end{aligned}$$

$$\begin{aligned}
 53. \quad & 2(s+2) + (s+3)^2 = s(s+5) + 2\left(\frac{17}{2} + s\right) \\
 & 2s + 4 + s^2 + 6s + 9 = s^2 + 5s + 17 + 2s \\
 & s^2 + 8s + 13 = s^2 + 7s + 17 \\
 & 8s + 13 = 7s + 17 \\
 & s = 4
 \end{aligned}$$

$$\begin{aligned}
 48. \quad & \frac{a(a-3)+5}{7} = \frac{(a-1)^2}{7} \\
 & 7\left[\frac{a(a-3)+5}{7}\right] = 7\left[\frac{(a-1)^2}{7}\right] \\
 & a(a-3)+5 = (a-1)(a-1) \\
 & a^2 - 3a + 5 = a^2 - 2a + 1 \\
 & -3a + 5 = -2a + 1 \\
 & 5 = a + 1 \\
 & 4 = a
 \end{aligned}$$

$$\begin{aligned}
 50. \quad & (t+1)(t-1) = (t+2)(t-3) + 4 \\
 & t^2 - 1 = t^2 - t - 6 + 4 \\
 & -1 = -t - 2 \\
 & t - 1 = -2 \\
 & t = -1
 \end{aligned}$$

$$\begin{aligned}
 52. \quad & (x-2)(x-3) = (x+3)(x+4) \\
 & x^2 - 5x + 6 = x^2 + 7x + 12 \\
 & -5x + 6 = 7x + 12 \\
 & -12x + 6 = 12 \\
 & -12x = 6 \\
 & x = -\frac{6}{12} = -\frac{1}{2}
 \end{aligned}$$

SECTION 1.1

$$\begin{aligned}
 54. \quad & \frac{3}{x} + \frac{1}{2} = \frac{4}{x} \\
 & 2x \left(\frac{3}{x} + \frac{1}{2} \right) = 2x \cdot \frac{4}{x} \\
 & 6 + x = 8 \\
 & x = 2
 \end{aligned}$$

$$\begin{aligned}
 55. \quad & \frac{2}{x+1} + \frac{1}{3} = \frac{1}{x+1} \\
 & 3(x+1) \left(\frac{2}{x+1} + \frac{1}{3} \right) = 3(x+1) \cdot \frac{1}{x+1} \\
 & 6 + 1(x+1) = 3(1) \\
 & 6 + x + 1 = 3 \\
 & x + 7 = 3 \\
 & x = -4
 \end{aligned}$$

$$\begin{aligned}
 56. \quad & \frac{3}{x-2} + \frac{1}{x} = \frac{3}{x-2} \\
 & x(x-2) \left(\frac{3}{x-2} + \frac{1}{x} \right) = x(x-2) \cdot \frac{3}{x-2} \\
 & 3x + 1(x-2) = 3x \\
 & 3x + x - 2 = 3x \\
 & 4x - 2 = 3x \\
 & x = 2
 \end{aligned}$$

$$\begin{aligned}
 57. \quad & \frac{9t+6}{t(t+3)} = \frac{7}{t+3} \\
 & t(t+3) \left[\frac{9t+6}{t(t+3)} \right] = t(t+3) \cdot \frac{7}{t+3} \\
 & 9t + 6 = 7t \\
 & 2t + 6 = 0 \\
 & 2t = -6 \\
 & t = -3
 \end{aligned}$$

The answer does not check. \Rightarrow no solution

The answer does not check. \Rightarrow no solution

$$\begin{aligned}
 58. \quad & x + \frac{2(-2x+1)}{3x+5} = \frac{3x^2}{3x+5} \\
 & (3x+5) \left[x + \frac{2(-2x+1)}{3x+5} \right] = (3x+5) \cdot \frac{3x^2}{3x+5} \\
 & x(3x+5) + 2(-2x+1) = 3x^2 \\
 & 3x^2 + 5x - 4x + 2 = 3x^2 \\
 & x + 2 = 0 \\
 & x = -2
 \end{aligned}$$

$$\begin{aligned}
 59. \quad & \frac{2}{(a-7)(a+2)} = \frac{4}{(a+3)(a+2)} \\
 & (a-7)(a+2)(a+3) \cdot \frac{2}{(a-7)(a+2)} = (a-7)(a+2)(a+3) \cdot \frac{4}{(a+3)(a+2)} \\
 & 2(a+3) = 4(a-7) \\
 & 2a + 6 = 4a - 28 \\
 & -2a = -34 \\
 & a = 17
 \end{aligned}$$

SECTION 1.1

$$\begin{aligned}
 60. \quad & \frac{2}{n-2} + \frac{1}{n+1} = \frac{1}{n^2 - n - 2} \\
 & \frac{2}{n-2} + \frac{1}{n+1} = \frac{1}{(n-2)(n+1)} \\
 & (n-2)(n+1) \left(\frac{2}{n-2} + \frac{1}{n+1} \right) = (n-2)(n+1) \cdot \frac{1}{(n-2)(n+1)} \\
 & 2(n+1) + 1(n-2) = 1 \\
 & 2n + 2 + n - 2 = 1 \\
 & 3n = 1 \\
 & n = \frac{1}{3}
 \end{aligned}$$

$$\begin{aligned}
 61. \quad & \frac{2x+3}{x^2+5x+6} + \frac{3x-2}{x^2+x-6} = \frac{5x-2}{x^2-4} \\
 & \frac{2x+3}{(x+3)(x+2)} + \frac{3x-2}{(x+3)(x-2)} = \frac{5x-2}{(x+2)(x-2)} \\
 & (x-2)(2x+3) + (x+2)(3x-2) = (x+3)(5x-2) \quad \{\text{multiply by common denominator}\} \\
 & 2x^2 - x - 6 + 3x^2 + 4x - 4 = 5x^2 + 13x - 6 \\
 & 5x^2 + 3x - 10 = 5x^2 + 13x - 6 \\
 & 3x - 10 = 13x - 6 \\
 & -10x = 4 \\
 & x = -\frac{4}{10} = -\frac{2}{5}
 \end{aligned}$$

$$\begin{aligned}
 62. \quad & \frac{3x}{x^2+x} - \frac{2x}{x^2+5x} = \frac{x+2}{x^2+6x+5} \\
 & \frac{3x}{x(x+1)} - \frac{2x}{x(x+5)} = \frac{x+2}{(x+5)(x+1)} \\
 & \frac{3}{x+1} - \frac{2}{x+5} = \frac{x+2}{(x+5)(x+1)} \\
 & 3(x+5) - 2(x+1) = x+2 \quad \{\text{multiply by common denominator}\} \\
 & 3x + 15 - 2x - 2 = x + 2 \\
 & x + 13 = x + 2 \\
 & 13 \neq 2 \Rightarrow \text{no solution}
 \end{aligned}$$

SECTION 1.1

$$\begin{aligned}
 \mathbf{63.} \quad & \frac{3x+5}{x^3+8} + \frac{3}{x^2-4} = \frac{2(3x-2)}{(x-2)(x^2-2x+4)} \\
 & \frac{3x+5}{(x+2)(x^2-2x+4)} + \frac{3}{(x+2)(x-2)} = \frac{2(3x-2)}{(x-2)(x^2-2x+4)} \\
 & (x-2)(3x+5) + (x^2-2x+4)(3) = 2(x+2)(3x-2) \quad \{\text{multiply by common denominator}\} \\
 & 3x^2 - x - 10 + 3x^2 - 6x + 12 = 6x^2 + 8x - 8 \\
 & 6x^2 - 7x + 2 = 6x^2 + 8x - 8 \\
 & -15x = -10 \\
 & x = \frac{-10}{-15} = \frac{2}{3}
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{64.} \quad & \frac{1}{n+8} - \frac{3n-4}{5n^2+42n+16} = \frac{1}{5n+2} \\
 & \frac{1}{n+8} - \frac{3n-4}{(5n+2)(n+8)} = \frac{1}{5n+2} \\
 & (5n+2)(1) - (3n-4) = n+8 \quad \{\text{multiply by common denominator}\} \\
 & 5n+2-3n+4 = n+8 \\
 & 2n+6 = n+8 \\
 & n = 2
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{65.} \quad & \frac{1}{11-n} - \frac{2(3n-1)}{-7n^2+74n+33} = \frac{1}{7n+3} \\
 & \frac{-1}{n-11} + \frac{2(3n-1)}{7n^2-74n-33} = \frac{1}{7n+3} \\
 & \frac{-1}{n-11} + \frac{6n-2}{(7n+3)(n-11)} = \frac{1}{7n+3} \\
 & -(7n+3) + 6n - 2 = (n-11)1 \quad \{\text{multiply by common denominator}\} \\
 & -7n - 3 + 6n - 2 = n - 11 \\
 & -n - 5 = n - 11 \\
 & -2n = -6 \\
 & n = 3
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{66.} \quad & \frac{4}{a^2-13a-48} - \frac{2}{a^2-18a+32} = \frac{1}{a^2+a-6} \\
 & \frac{4}{(a-16)(a+3)} - \frac{2}{(a-16)(a-2)} = \frac{1}{(a+3)(a-2)} \\
 & 4(a-2) - 2(a+3) = 1(a-16) \quad \{\text{multiply by common denominator}\} \\
 & 4a - 8 - 2a - 6 = a - 16 \\
 & 2a - 14 = a - 16 \\
 & a = -2
 \end{aligned}$$

SECTION 1.1

$$\begin{aligned}
 67. \quad \frac{5}{y+4} + \frac{2}{y+2} &= \frac{6}{y+2} - \frac{1}{y^2+6y+8} \\
 \frac{5}{y+4} &= \frac{4}{y+2} - \frac{1}{(y+2)(y+4)} \\
 5(y+2) &= 4(y+4) - 1 \quad \{\text{multiply by common denominator}\} \\
 5y+10 &= 4y+16-1 \\
 5y+10 &= 4y+15 \\
 y &= 5
 \end{aligned}$$

$$\begin{aligned}
 68. \quad \frac{6}{2a-6} - \frac{3}{3-3a} &= \frac{1}{a^2-4a+3} \\
 \frac{6}{6} - \frac{3}{3} &= \frac{1}{1} \\
 2(a-3) - 3(1-a) &= (a-3)(a-1) \\
 \frac{3}{a-3} + \frac{1}{a-1} &= \frac{1}{(a-3)(a-1)} \\
 3(a-1) + 1(a-3) &= 1 \quad \{\text{multiply by common denominator}\} \\
 3a-3+a-3 &= 1 \\
 4a-6 &= 1 \\
 4a &= 7 \\
 a &= \frac{7}{4}
 \end{aligned}$$

$$\begin{aligned}
 69. \quad \frac{3y}{6-3y} + \frac{2y}{2y+4} &= \frac{8}{4-y^2} \\
 \frac{3y}{3(2-y)} + \frac{2y}{2(y+2)} &= \frac{8}{(2+y)(2-y)} \\
 \frac{y}{2-y} + \frac{y}{2+y} &= \frac{8}{(2+y)(2-y)} \\
 y(2+y) + y(2-y) &= 8 \quad \{\text{multiply by common denominator}\} \\
 2y+y^2+2y-y^2 &= 8 \\
 4y &= 8 \\
 y = 2 &\Rightarrow \text{The solution does not check, so the equation has no solution.}
 \end{aligned}$$

$$\begin{aligned}
 70. \quad \frac{3+2a}{a^2+6+5a} - \frac{2-3a}{a^2-6+a} &= \frac{5a-2}{a^2-4} \\
 \frac{2a+3}{(a+2)(a+3)} + \frac{3a-2}{(a+3)(a-2)} &= \frac{5a-2}{(a+2)(a-2)} \\
 (a-2)(2a+3) + (a+2)(3a-2) &= (a+3)(5a-2) \quad \{\text{multiply by common denominator}\} \\
 2a^2-a-6+3a^2+4a-4 &= 5a^2+13a-6 \\
 5a^2+3a-10 &= 5a^2+13a-6 \\
 -10a &= 4 \\
 a &= \frac{4}{-10} = -\frac{2}{5}
 \end{aligned}$$

SECTION 1.1

71.
$$\frac{a}{a+2} - 1 = -\frac{3a+2}{a^2+4a+4}$$

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

$$(a+2)(a+2) \left[\frac{a}{a+2} - 1 \right] = (a+2)(a+2) \cdot \left[-\frac{3a+2}{(a+2)(a+2)} \right]$$

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

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

$$a^2 + 2a - a^2 - 4a - 4 = -3a - 2$$

$$-2a - 4 = -3a - 2$$

$$a = 2$$

72.
$$\frac{x-1}{x+3} + \frac{x-2}{x-3} = \frac{1-2x}{3-x}$$

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

$$(x-3)(x-1) + (x+3)(x-2) = (x+3)(2x-1) \quad \{\text{multiply by common denominator}\}$$

$$x^2 - 4x + 3 + x^2 + x - 6 = 2x^2 + 5x - 3$$

$$2x^2 - 3x - 3 = 2x^2 + 5x - 3$$

$$-8x = 0$$

$$x = \frac{0}{-8} = 0$$

73. $k = 2.2p$
 $\frac{k}{2.2} = \frac{2.2p}{2.2}$
 $\frac{k}{2.2} = p$

74. $ax + b = 0$
 $ax = -b$
 $x = -\frac{b}{a}$

75. $p = 2l + 2w$
 $p - 2l = 2w$
 $\frac{p-2l}{2} = \frac{2w}{2}$
 $\frac{p-2l}{2} = w$

76. $V = \frac{1}{3}\pi r^2 h$
 $3V = 3 \cdot \frac{1}{3}\pi r^2 h$
 $3V = \pi r^2 h$
 $\frac{3V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2}$
 $\frac{3V}{\pi r^2} = h$

77. $V = \frac{1}{3}\pi r^2 h$
 $3V = 3 \cdot \frac{1}{3}\pi r^2 h$
 $3V = \pi r^2 h$
 $\frac{3V}{\pi h} = \frac{\pi r^2 h}{\pi h}$
 $\frac{3V}{\pi h} = r^2$

78. $z = \frac{x-\mu}{\sigma}$
 $z\sigma = \frac{x-\mu}{\sigma} \cdot \sigma$
 $z\sigma = x - \mu$
 $\mu + z\sigma = x$
 $\mu = x - z\sigma$

SECTION 1.1

$$\begin{aligned}
 79. \quad P_n &= L + \frac{si}{f} \\
 P_n - L &= \frac{si}{f} \\
 f(P_n - L) &= f \cdot \frac{si}{f} \\
 f(P_n - L) &= si \\
 \frac{f(P_n - L)}{i} &= \frac{si}{i} \\
 \frac{f(P_n - L)}{i} &= s
 \end{aligned}$$

$$\begin{aligned}
 80. \quad P_n &= L + \frac{si}{f} \\
 P_n - L &= \frac{si}{f} \\
 f(P_n - L) &= f \cdot \frac{si}{f} \\
 f(P_n - L) &= si \\
 \frac{f(P_n - L)}{P_n - L} &= \frac{si}{P_n - L} \\
 f &= \frac{si}{P_n - L}
 \end{aligned}$$

$$\begin{aligned}
 81. \quad F &= \frac{mMg}{r^2} \\
 Fr^2 &= \frac{mMg}{r^2} \cdot r^2 \\
 Fr^2 &= mMg \\
 \frac{Fr^2}{Mg} &= \frac{mMg}{Mg} \\
 \frac{Fr^2}{Mg} &= m
 \end{aligned}$$

$$\begin{aligned}
 82. \quad \frac{1}{f} &= \frac{1}{p} + \frac{1}{q} \\
 fpq \cdot \frac{1}{f} &= fpq \left(\frac{1}{p} + \frac{1}{q} \right) \\
 pq &= fq + fp \\
 pq &= f(q + p) \\
 \frac{pq}{q + p} &= \frac{f(q + p)}{q + p} \\
 \frac{pq}{q + p} &= f
 \end{aligned}$$

$$\begin{aligned}
 83. \quad \frac{x}{a} + \frac{y}{b} &= 1 \\
 \frac{y}{b} &= 1 - \frac{x}{a} \\
 b \cdot \frac{y}{b} &= b \left(1 - \frac{x}{a} \right) \\
 y &= b \left(1 - \frac{x}{a} \right)
 \end{aligned}$$

$$\begin{aligned}
 84. \quad \frac{x}{a} - \frac{y}{b} &= 1 \\
 ab \left(\frac{x}{a} - \frac{y}{b} \right) &= ab \cdot 1 \\
 bx - ay &= ab \\
 bx &= ab + ay \\
 bx &= a(b + y) \\
 \frac{bx}{b + y} &= \frac{a(b + y)}{b + y} \\
 \frac{bx}{b + y} &= a
 \end{aligned}$$

$$\begin{aligned}
 85. \quad \frac{1}{r} &= \frac{1}{r_1} + \frac{1}{r_2} \\
 rr_1r_2 \cdot \frac{1}{r} &= rr_1r_2 \left(\frac{1}{r_1} + \frac{1}{r_2} \right) \\
 r_1r_2 &= rr_2 + rr_1 \\
 r_1r_2 &= r(r_2 + r_1) \\
 \frac{r_1r_2}{r_2 + r_1} &= \frac{r(r_2 + r_1)}{r_2 + r_1} \\
 \frac{r_1r_2}{r_2 + r_1} &= r
 \end{aligned}$$

$$\begin{aligned}
 86. \quad \frac{1}{r} &= \frac{1}{r_1} + \frac{1}{r_2} \\
 rr_1r_2 \cdot \frac{1}{r} &= rr_1r_2 \left(\frac{1}{r_1} + \frac{1}{r_2} \right) \\
 r_1r_2 &= rr_2 + rr_1 \\
 r_1r_2 - rr_1 &= rr_2 \\
 r_1(r_2 - r) &= rr_2 \\
 \frac{r_1(r_2 - r)}{r_2 - r} &= \frac{rr_2}{r_2 - r} \\
 r_1 &= \frac{rr_2}{r_2 - r}
 \end{aligned}$$

$$\begin{aligned}
 87. \quad l &= a + (n - 1)d \\
 l &= a + nd - d \\
 l - a + d &= nd \\
 \frac{l - a + d}{d} &= \frac{nd}{d} \\
 \frac{l - a + d}{d} &= n
 \end{aligned}$$

$$\begin{aligned}
 88. \quad l &= a + (n - 1)d \\
 l - a &= (n - 1)d \\
 \frac{l - a}{n - 1} &= \frac{(n - 1)d}{n - 1} \\
 \frac{l - a}{n - 1} &= d
 \end{aligned}$$

SECTION 1.1

$$\begin{aligned}
 89. \quad a &= (n-2)\frac{180}{n} \\
 an &= (n-2)\frac{180}{n} \cdot n \\
 an &= (n-2)180 \\
 an &= 180n - 360 \\
 360 &= 180n - an \\
 360 &= n(180 - a) \\
 \frac{360}{180 - a} &= n
 \end{aligned}$$

$$\begin{aligned}
 90. \quad S &= \frac{a - lr}{1 - r} \\
 S(1 - r) &= \frac{a - lr}{1 - r}(1 - r) \\
 S(1 - r) &= a - lr \\
 S - Sr + lr &= a
 \end{aligned}$$

$$\begin{aligned}
 91. \quad R &= \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} \\
 R &= \frac{r_1 r_2 r_3 (1)}{r_1 r_2 r_3 \left(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} \right)} \\
 R &= \frac{r_1 r_2 r_3}{r_2 r_3 + r_1 r_3 + r_1 r_2} \\
 R(r_2 r_3 + r_1 r_3 + r_1 r_2) &= r_1 r_2 r_3 \\
 Rr_2 r_3 + Rr_1 r_3 + Rr_1 r_2 &= r_1 r_2 r_3 \\
 Rr_1 r_3 + Rr_1 r_2 - r_1 r_2 r_3 &= -Rr_2 r_3 \\
 r_1(Rr_3 + Rr_2 - r_2 r_3) &= -Rr_2 r_3 \\
 r_1 &= \frac{-Rr_2 r_3}{Rr_3 + Rr_2 - r_2 r_3}
 \end{aligned}$$

$$\begin{aligned}
 92. \quad R &= \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} \\
 R &= \frac{r_1 r_2 r_3 (1)}{r_1 r_2 r_3 \left(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} \right)} \\
 R &= \frac{r_1 r_2 r_3}{r_2 r_3 + r_1 r_3 + r_1 r_2} \\
 R(r_2 r_3 + r_1 r_3 + r_1 r_2) &= r_1 r_2 r_3 \\
 Rr_2 r_3 + Rr_1 r_3 + Rr_1 r_2 &= r_1 r_2 r_3 \\
 Rr_2 r_3 + Rr_1 r_3 - r_1 r_2 r_3 &= -Rr_1 r_2 \\
 r_3(Rr_2 + Rr_1 - r_1 r_2) &= -Rr_1 r_2 \\
 r_3 &= \frac{-Rr_1 r_2}{Rr_2 + Rr_1 - r_1 r_2}
 \end{aligned}$$

93. Answers may vary.

94. Answers may vary.

$$95. (25x^2)^{1/2} = [(5x)^2]^{1/2} = 5|x|$$

$$96. \left(\frac{25p^2}{16q^4} \right)^{1/2} = \left[\left(\frac{5p}{4q^2} \right)^2 \right]^{1/2} = \frac{5|p|}{4q^2}$$

SECTION 1.1

$$97. \left(\frac{125x^3}{8y^6}\right)^{-2/3} = \left(\frac{8y^6}{125x^3}\right)^{2/3}$$

$$= \frac{8^{2/3}(y^6)^{2/3}}{125^{2/3}(x^3)^{2/3}} = \frac{4y^4}{25x^2}$$

$$98. \left(-\frac{27y^3}{1,000x^6}\right)^{1/3} = \frac{(-27)^{1/3}(y^3)^{1/3}}{1,000^{1/3}(x^6)^{1/3}}$$

$$= \frac{-3y}{10x^2} = -\frac{3y}{10x^2}$$

$$99. \sqrt{25y^2} = \sqrt{(5y)^2} = 5|y|$$

$$100. \sqrt[3]{-125y^9} = \sqrt[3]{(-5y^3)^3} = -5y^3$$

$$101. \sqrt[4]{\frac{a^4b^{12}}{z^8}} = \sqrt[4]{\left(\frac{ab^3}{z^2}\right)^4} = \frac{|ab^3|}{z^2}$$

$$102. \sqrt[5]{\frac{x^{10}y^5}{z^{15}}} = \sqrt[5]{\left(\frac{x^2y}{z^3}\right)^5} = \frac{x^2y}{z^3}$$

Exercises 1.2 (page 101)

1. add

2. perimeter

3. amount

4. break point

5. rate, time

6. $0.05(30) = 1.5$

7. Let x = the score on the first exam.
Then $x + 5$ = the score on the midterm,
and $x + 13$ = the score on the final.

$$\frac{\text{Sum of scores}}{3} = 90$$

$$\frac{x + x + 5 + x + 13}{3} = 90$$

$$\frac{3x + 18}{3} = 90$$

$$3x + 18 = 270$$

$$3x = 252$$

$$x = 84$$

His score on the first exam was 84.

8. Let x = the score on the first exam. Then her
scores on the following tests were $x + 3$,
 $x + 6$ and $x + 9$.

$$\frac{\text{Sum of scores}}{4} = 69.5$$

$$\frac{x + x + 3 + x + 6 + x + 9}{4} = 69.5$$

$$\frac{4x + 18}{4} = 69.5$$

$$4x + 18 = 278$$

$$4x = 260$$

$$x = 65$$

Her score on the first exam was 65%.

9. Let x = the program development score.

$$\frac{\text{Sum of scores}}{4} = 86$$

$$\frac{82 + 90 + x + 78}{4} = 86$$

$$\frac{x + 250}{4} = 86$$

$$x + 250 = 344$$

$$x = 94$$

The program development score was 94.

10. Let x = the score on the final round.

$$\frac{\text{Sum of scores}}{4} = 72$$

$$\frac{76 + 68 + 70 + x}{4} = 72$$

$$\frac{x + 214}{4} = 72$$

$$x + 214 = 288$$

$$x = 74$$

She needs to shoot 74 on the final round.

SECTION 1.2

11. Let x = the number of locks replaced.

$$40 + 28 \cdot \boxed{\text{Number of locks}} = 236$$

$$40 + 28x = 236$$

$$28x = 196$$

$$x = 7$$

7 locks can be changed for \$236.

12. Let x = the number of interviews.

$$20 + 0.75 \cdot \boxed{\text{Number of interviews}} = 56$$

$$20 + 0.75x = 56$$

$$0.75x = 36$$

$$x = 48$$

He interviewed 48 people.

13. Let x = the width.

Then $x + 26$ = the height.

$$\boxed{\text{Perimeter}} = 92$$

$$2x + 2(x + 26) = 92$$

$$2x + 2x + 52 = 92$$

$$4x = 40$$

$$x = 10$$

The dimensions are 10 ft by 36 ft.

14. Let x = the width.

Then $x + 115$ = the length.

$$\boxed{\text{Perimeter}} = 570$$

$$2x + 2(x + 115) = 570$$

$$2x + 2x + 230 = 570$$

$$4x = 340$$

$$x = 85$$

The dimensions are 85 ft by 200 ft.

15. $\boxed{\text{Perimeter}} = 14$

$$x + (x + 2) + x + (x + 2) = 14$$

$$4x + 4 = 14$$

$$4x = 10$$

$$x = \frac{5}{2} = 2\frac{1}{2} \Rightarrow \text{The width is } 2\frac{1}{2} \text{ feet.}$$

16. $\boxed{\text{Total Fence Length}} = 2 \cdot \boxed{\text{Square Fence Length}}$

$$x + (x + 24) + x + (x + 24) = 2 \cdot (x + x + x + x)$$

$$4x + 48 = 8x$$

$$48 = 4x$$

$$x = 12$$

The total fencing required is $4x + 48 = 4(12) + 48 = 96$ feet.

17. $\boxed{\text{Total Area}} = 2 \cdot \boxed{\text{Triangular Area}}$

$$20x + \frac{1}{2}(16)(20) = 2 \cdot \frac{1}{2}(16)(20)$$

$$20x + 160 = 320$$

$$20x = 160$$

$$x = 8$$

The dimensions are 8 feet by 20 feet.

18. $\boxed{\text{Sum of angles}} = 180$

$$x + x + 30 + x + 30 = 180$$

$$3x + 60 = 180$$

$$3x = 120$$

$$x = 40$$

The angles measure 40° , 70° and 70° .

SECTION 1.2

19.
$$\boxed{\text{New Area}} = \boxed{\text{Old Area}} + 0.50 \cdot \boxed{\text{Old Area}}$$

$$12(x + 10) + 12x = 12(x + 10) + 0.50 \cdot 12(x + 10)$$

$$12x + 120 + 12x = 12x + 120 + 6x + 60$$

$$24x + 120 = 18x + 180$$

$$6x = 60$$

$$x = 10 \Rightarrow \text{The length of the living room is } x + 10 = 20 \text{ feet.}$$

20.
$$\boxed{\text{Area}} = 54$$

$$\frac{1}{2}d(12 + 8) = 54$$

$$10d = 54$$

$$d = 5.4 \Rightarrow \text{The depth is 5.4 inches}$$

21. Let x = the amount invested at 7%. Then $22000 - x$ = the amount invested at 6%.

$$\boxed{\text{Interest at 7\%}} + \boxed{\text{Interest at 6\%}} = \boxed{\text{Total interest}}$$

$$0.07x + 0.06(22000 - x) = 1420$$

$$0.07x + 1320 - 0.06x = 1420$$

$$0.01x = 100$$

$$x = 10000$$

\$10,000 was invested at 7% and \$12,000 was invested at 6%.

22. Let x = the amount invested at 7%.

$$\boxed{\text{Interest at 7\%}} + \boxed{\text{Interest at 9\%}} = \boxed{\text{Total interest}}$$

$$0.07x + 0.09(20000) = 5000$$

$$0.07x + 1800 = 5000$$

$$0.07x = 3200$$

$$x \approx 45714.29$$

She needs to invest \$45,714.29 at 7% to reach her goal.

23. Let x = the amount invested at each rate.

$$\boxed{\text{Interest at 6\%}} + \boxed{\text{Interest at 7\%}} + \boxed{\text{Interest at 8\%}} = \boxed{\text{Total interest}}$$

$$0.06x + 0.07x + 0.08x = 2037$$

$$0.21x = 2037$$

$$x = 9700$$

\$9,700 was invested at each rate, for a total investment of \$29,100.

SECTION 1.2

24. Let x = the amount invested at 8%. Then $37,000 - x$ = the amount invested at $9\frac{1}{2}\%$.

$$\boxed{\text{Interest at } 9\frac{1}{2}\%} = \boxed{\text{Interest at } 8\%} + 452.50$$

$$0.095(37,000 - x) = 0.08x + 452.50$$

$$3515 - 0.095x = 0.08x + 452.50$$

$$3062.50 = 0.175x$$

$$17500 = x$$

\$17,500 is invested at 8% and \$19,500 is invested at $9\frac{1}{2}\%$.

25. Let x = the number of full-price tickets sold. Then $585 - x$ = the number of student tickets sold.

$$2.50 \cdot \boxed{\text{\# of full-price}} + 1.75 \cdot \boxed{\text{\# of student}} = 1217.25$$

$$2.50x + 1.75(585 - x) = 1217.25$$

$$2.50x + 1023.75 - 1.75x = 1217.25$$

$$0.75x = 193.50$$

$$x = 258 \Rightarrow \text{There were 327 student tickets sold.}$$

26. Let x = the cost of a student ticket.

$$\boxed{\text{Cost of full-price}} \cdot \boxed{\text{\# of full-price}} + \boxed{\text{Cost of student}} \cdot \boxed{\text{\# of student}} = 4960$$

$$480(7) + x(800 - 480) = 4960$$

$$3360 + 320x = 4960$$

$$320x = 1600$$

$$x = 5 \Rightarrow \text{A student ticket cost \$5.}$$

27. Let p = the original price.

$$\boxed{\text{Original price}} - \boxed{\text{Discount}} = \boxed{\text{New price}}$$

$$p - 0.20p = 63.96$$

$$0.80p = 63.96$$

$$p = 79.95$$

The original price was \$79.95.

28. Let w = the wholesale cost.

$$\boxed{\text{Wholesale cost}} + \boxed{\text{Markup}} = \boxed{\text{Selling price}}$$

$$w + 0.30w = 588.90$$

$$1.30w = 588.90$$

$$w = 453$$

The wholesale cost is \$453.

29. Let x = # of plates for equal costs.

$$\boxed{\text{Cost of 1st machine}} = \boxed{\text{Cost of 2nd machine}}$$

$$600 + 3x = 800 + 2x$$

$$x = 200$$

The break point is 200 plates.

30. Let x = # of fasteners for equal costs.

$$\boxed{\text{Cost of 1st machine}} = \boxed{\text{Cost of 2nd machine}}$$

$$1200 + 0.005x = 1500 + 0.0015x$$

$$0.0035x = 300$$

$$x \approx 85714$$

The break point is about 85,714 fasteners.

SECTION 1.2

31. Let
- $x = \#$
- of computers to break even.

$$\begin{aligned} \boxed{\text{Income}} &= \boxed{\text{Expenses}} \\ 1275x &= 8925 + 850x \\ 425x &= 8925 \\ x &= 21 \end{aligned}$$

21 computers need to be sold to break even.

32. Let
- $x = \#$
- of meals to break even.

$$\begin{aligned} \boxed{\text{Income}} &= \boxed{\text{Expenses}} \\ 6x &= 137.50 + 4.75x \\ 1.25x &= 137.50 \\ x &= 110 \end{aligned}$$

More than 110 meals need to be sold to make a profit.

33. Let
- $x =$
- days for both working together.

$$\begin{aligned} \boxed{\text{Man in 1 day}} + \boxed{\text{Roofer in 1 day}} &= \boxed{\text{Total in 1 day}} \\ \frac{1}{7} + \frac{1}{4} &= \frac{1}{x} \\ 28x \left(\frac{1}{7} + \frac{1}{4} \right) &= 28x \left(\frac{1}{x} \right) \\ 4x + 7x &= 28 \\ 11x &= 28 \\ x &= \frac{28}{11} = 2\frac{6}{11} \end{aligned}$$

They can roof the house in $2\frac{6}{11}$ days.

34. Let
- $x =$
- hours for both working together.

$$\begin{aligned} \boxed{\text{Crew 1 in 1 hour}} + \boxed{\text{Crew 2 in 1 hour}} &= \boxed{\text{Total in 1 hour}} \\ \frac{1}{8} + \frac{1}{10} &= \frac{1}{x} \\ 40x \left(\frac{1}{8} + \frac{1}{10} \right) &= 40x \left(\frac{1}{x} \right) \\ 5x + 4x &= 40 \\ 9x &= 40 \\ x &= \frac{40}{9} = 4\frac{4}{9} \end{aligned}$$

They can seal the parking lot in $4\frac{4}{9}$ hours.

35. Let
- $x =$
- hours for both working together.

$$\begin{aligned} \boxed{\text{Woman in 1 hour}} + \boxed{\text{Man in 1 hour}} &= \boxed{\text{Total in 1 hour}} \\ \frac{1}{2} + \frac{1}{4} &= \frac{1}{x} \\ 4x \left(\frac{1}{2} + \frac{1}{4} \right) &= 4x \left(\frac{1}{x} \right) \\ 2x + x &= 4 \\ 3x &= 4 \\ x &= \frac{4}{3} = 1\frac{1}{3} \end{aligned}$$

They can mow the lawn in $1\frac{1}{3}$ hours.

36. Let
- $x =$
- days for both hoses to fill the pool.

$$\begin{aligned} \boxed{\text{1st hose in 1 day}} + \boxed{\text{2nd hose in 1 day}} &= \boxed{\text{Total in 1 day}} \\ \frac{1}{3} + \frac{1}{2} &= \frac{1}{x} \\ 6x \left(\frac{1}{3} + \frac{1}{2} \right) &= 6x \left(\frac{1}{x} \right) \\ 2x + 3x &= 6 \\ 5x &= 6 \\ x &= \frac{6}{5} = 1\frac{1}{5} \end{aligned}$$

The pool can be filled in $1\frac{1}{5}$ days.