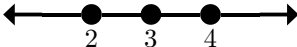

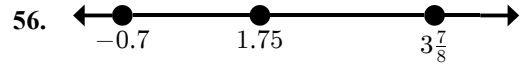
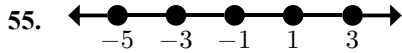
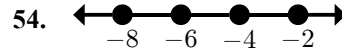
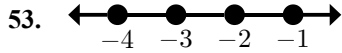
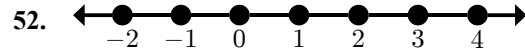
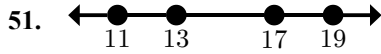


SECTION 0.1

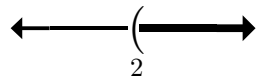
**Exercises 0.1** (page 13)

- |  |  |   |  |
|--|--|---|--|
| 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,<br>multiplication   | 19. interval  | 20. no   |
| 21. two  | 22. half-open  | 23. positive  | 24. distance   |
| 25. Every natural number is a whole number,<br>so $\mathbf{N} \subset \mathbf{W}$ . <span style="border: 1px solid black; padding: 2px;">TRUE</span> | 26. Every rational number is a real number,<br>so $\mathbf{Q} \subset \mathbf{R}$ . <span style="border: 1px solid black; padding: 2px;">TRUE</span>                   | 27. The rational number $\frac{1}{2}$ is <b>not</b> a natural<br>number, so $\mathbf{Q} \not\subset \mathbf{N}$ . <span style="border: 1px solid black; padding: 2px;">FALSE</span> | 28. Every integer is a rational number,<br>so $\mathbf{Z} \subset \mathbf{Q}$ . <span style="border: 1px solid black; padding: 2px;">TRUE</span> |
| 29. Every whole number is an integer,<br>so $\mathbf{W} \subset \mathbf{Z}$ . <span style="border: 1px solid black; padding: 2px;">TRUE</span>       | 30. The real number $\sqrt{2}$ is <b>not</b> an integer,<br>so $\mathbf{R} \not\subset \mathbf{Z}$ . <span style="border: 1px solid black; padding: 2px;">FALSE</span> | 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. $\frac{9}{16} = 0.5625$ ; <span style="border: 1px solid black; padding: 2px;">terminates</span>  | 36. $\frac{3}{8} = 0.375$ ; <span style="border: 1px solid black; padding: 2px;">terminates</span>   |
| 37. $\frac{3}{11} = 0.272727\dots$ ; <span style="border: 1px solid black; padding: 2px;">repeats</span>   | 38. $\frac{5}{12} = 0.416666\dots$ ; <span style="border: 1px solid black; padding: 2px;">repeats</span>   | 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.    |   |  |

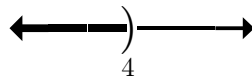
SECTION 0.1



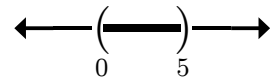
57.  $x > 2 \rightarrow (2, \infty)$



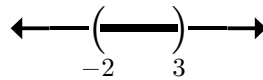
58.  $x < 4 \rightarrow (-\infty, 4)$



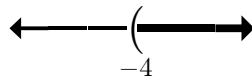
59.  $0 < x < 5 \rightarrow (0, 5)$



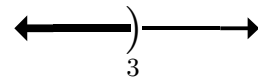
60.  $-2 < x < 3 \rightarrow (-2, 3)$



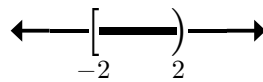
61.  $x > -4 \rightarrow (-4, \infty)$



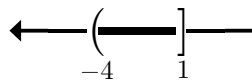
62.  $x < 3 \rightarrow (-\infty, 3)$



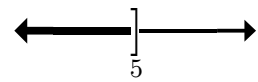
63.  $-2 \leq x < 2 \rightarrow [-2, 2)$



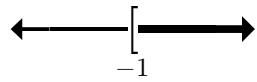
64.  $-4 < x \leq 1 \rightarrow (-4, 1]$



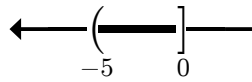
65.  $x \leq 5 \rightarrow (-\infty, 5]$



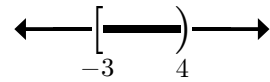
66.  $x \geq -1 \rightarrow [-1, \infty)$



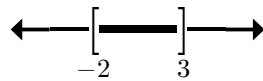
67.  $-5 < x \leq 0 \rightarrow (-5, 0]$



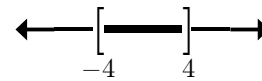
68.  $-3 \leq x < 4 \rightarrow [-3, 4)$



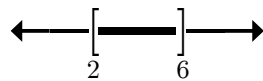
69.  $-2 \leq x \leq 3 \rightarrow [-2, 3]$



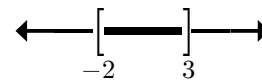
70.  $-4 \leq x \leq 4 \rightarrow [-4, 4]$



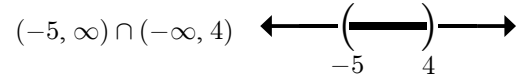
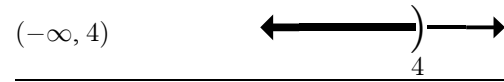
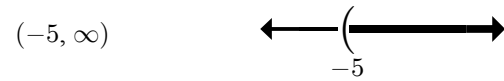
71.  $6 \geq x \geq 2 \rightarrow 2 \leq x \leq 6 \rightarrow [2, 6]$



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

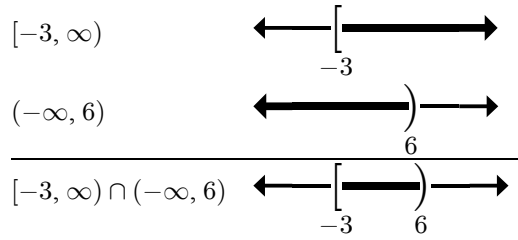


73.  $x > -5$  and  $x < 4 \rightarrow (-5, \infty) \cap (-\infty, 4)$

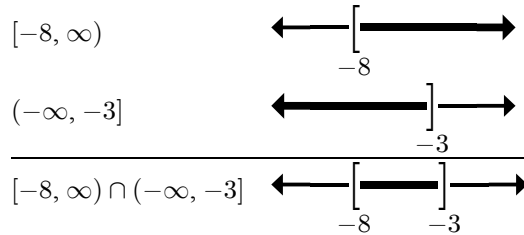


SECTION 0.1

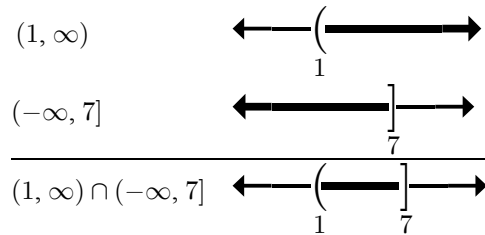
74.  $x \geq -3$  and  $x < 6 \rightarrow [-3, \infty) \cap (-\infty, 6)$



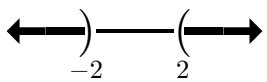
75.  $x \geq -8$  and  $x \leq -3 \rightarrow [-8, \infty) \cap (-\infty, -3]$



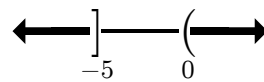
76.  $x > 1$  and  $x \leq 7 \rightarrow (1, \infty) \cap (-\infty, 7]$



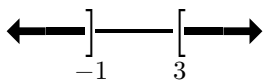
77.  $x < -2$  or  $x > 2 \rightarrow (-\infty, -2) \cup (2, \infty)$



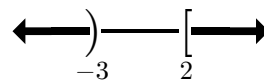
78.  $x \leq -5$  or  $x > 0 \rightarrow (-\infty, -5] \cup (0, \infty)$



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 0.3

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.  $\sqrt{9y^4} = \sqrt{(3y^2)^2} = |3y^2| = 3y^2$
76.  $\sqrt{a^4b^8} = \sqrt{(a^2b^4)^2} = |a^2b^4| = a^2b^4$
77.  $\sqrt[3]{8y^3} = \sqrt[3]{(2y)^3} = 2y$
78.  $\sqrt[3]{-27z^9} = \sqrt[3]{(-3z^3)^3} = -3z^3$
79.  $\sqrt[4]{\frac{x^4y^8}{z^{12}}} = \sqrt[4]{\left(\frac{xy^2}{z^3}\right)^4} = \left|\frac{xy^2}{z^3}\right| = \frac{|x|y^2}{|z^3|}$
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.  $2\sqrt{48y^5} - 3y\sqrt{12y^3} = 2\sqrt{16y^4}\sqrt{3y} - 3y\sqrt{4y^2}\sqrt{3y} = 2(4y^2)\sqrt{3y} - 3y(2y)\sqrt{3y}$   
 $= 8y^2\sqrt{3y} - 6y^2\sqrt{3y} = 2y^2\sqrt{3y}$
86.  $y\sqrt{112y} + 4\sqrt{175y^3} = y\sqrt{16}\sqrt{7y} + 4\sqrt{25y^2}\sqrt{7y} = y(4)\sqrt{7y} + 4(5y)\sqrt{7y}$   
 $= 4y\sqrt{7y} + 20y\sqrt{7y} = 24y\sqrt{7y}$
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.  $-2\sqrt[5]{64y^2} + 3\sqrt[5]{486y^2} = -2\sqrt[5]{32}\sqrt[5]{2y^2} + 3\sqrt[5]{243}\sqrt[5]{2y^2} = -2(2)\sqrt[5]{2y^2} + 3(3)\sqrt[5]{2y^2}$   
 $= -4\sqrt[5]{2y^2} + 9\sqrt[5]{2y^2} = 5\sqrt[5]{2y^2}$
91.  $\sqrt{8x^2y} - x\sqrt{2y} + \sqrt{50x^2y} = \sqrt{4x^2}\sqrt{2y} - x\sqrt{2y} + \sqrt{25x^2}\sqrt{2y}$   
 $= 2x\sqrt{2y} - x\sqrt{2y} + 5x\sqrt{2y} = 6x\sqrt{2y}$
92.  $3x\sqrt{18x} + 2\sqrt{2x^3} - \sqrt{72x^3} = 3x\sqrt{9}\sqrt{2x} + 2\sqrt{x^2}\sqrt{2x} - \sqrt{36x^2}\sqrt{2x}$   
 $= 3x(3)\sqrt{2x} + 2x\sqrt{2x} - 6x\sqrt{2x}$   
 $= 9x\sqrt{2x} + 2x\sqrt{2x} - 6x\sqrt{2x} = 5x\sqrt{2x}$
93.  $\sqrt[3]{16xy^4} + y\sqrt[3]{2xy} - \sqrt[3]{54xy^4} = \sqrt[3]{8y^3}\sqrt[3]{2xy} + y\sqrt[3]{2xy} - \sqrt[3]{27y^3}\sqrt[3]{2xy}$   
 $= 2y\sqrt[3]{2xy} + y\sqrt[3]{2xy} - 3y\sqrt[3]{2xy} = 0$

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

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

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

$$125. \sqrt[4]{x^4} = |x|. \text{ Since } |x| = x \text{ if } x \geq 0, \text{ then } \sqrt[4]{x^4} = x \text{ if } x \geq 0. \quad 126. \sqrt[n]{\frac{x}{y}} = \left(\frac{x}{y}\right)^{1/n} = \frac{x^{1/n}}{y^{1/n}} = \frac{\sqrt[n]{x}}{\sqrt[n]{y}}$$

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

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.

$$129. -2 < x \leq 5 \Rightarrow (-2, 5]$$

$$130. \text{ If } x > 4, \text{ then } 3 - x < 0. \text{ Then } |3 - x| = -(3 - x) = -3 + x = x - 3.$$

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

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

$$133. 617,000,000 = 6.17 \times 10^8$$

$$134. 0.00235 \times 10^4 = 23.5$$

### 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.**  $-3m^2n(2mn^2)\left(-\frac{mn}{12}\right) = (-3)(2)\left(-\frac{1}{12}\right)m^2mmn^2n = \frac{6}{12}m^4n^4 = \frac{m^4n^4}{2}$
- 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

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

123. Area = length · width =  $(x + 5)(x - 2)$  ft<sup>2</sup> =  $(x^2 - 2x + 5x - 10)$  ft<sup>2</sup> =  $(x^2 + 3x - 10)$  ft<sup>2</sup>

$$\begin{array}{l}
 124. \quad \text{Area} = \frac{1}{2} \cdot \text{base} \cdot \text{height} \\
 x^2 + 3x - 40 = \frac{1}{2}(x + 8) \cdot \text{height} \\
 2(x^2 + 3x - 40) = (x + 8) \cdot \text{height} \\
 2x^2 + 6x - 80 = (x + 8) \cdot \text{height} \\
 \frac{2x^2 + 6x - 80}{x + 8} = \text{height}
 \end{array}
 \quad
 \begin{array}{l}
 x + 8 \overline{) \begin{array}{l} 2x - 10 \\ 2x^2 + 6x - 80 \\ \hline -10x - 80 \\ -10x - 80 \\ \hline 0 \end{array}} \\
 \text{The height is } (2x - 10) \text{ ft.}
 \end{array}$$

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

$$\begin{array}{r}
 3x + 4 \overline{) \begin{array}{l} x + 5 \\ 3x^2 + 19x + 20 \\ \hline 3x^2 + 4x \\ \hline 15x + 20 \\ 15x + 20 \\ \hline 0 \end{array}} \\
 t = x + 5
 \end{array}$$

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