



Radical Expressions and Equations

pages 576–633

DIAGNOSING READINESS

page 576

1. mean: $\frac{1+4+2+5+3+2}{6} = \frac{17}{6} = 2.8\bar{3}$, or $2\frac{5}{6}$
2. mean: $\frac{40+55+60+52}{4} = \frac{207}{4} = 51.75$
3. mean: $\frac{1.6+2.1+1.8+1.8}{4} = \frac{7.3}{4} = 1.825$
4. mean: $\frac{-4+2+0+(-1)}{4} = \frac{-3}{4} = -0.75$
5. mean: $\frac{214+198+202}{3} = \frac{614}{3} = 204.\bar{6}$
6. mean: $\frac{3+2+2+3+4+4}{6} = \frac{18}{6} = 3$ 7. $\frac{8}{x} = \frac{24}{9}$; $8(9) = x(24)$; $24x = 72$; $x = 3$ 8. $\frac{k-4}{27} = \frac{1}{3}$; $(k-4)(3) = 27(1)$; $3k-12 = 27$; $3k = 39$; $k = 13$ 9. $\frac{5}{6} = \frac{25}{c}$; $5c = 6(25)$; $5c = 150$; $c = 30$ 10. $\frac{42}{x+8} = \frac{7}{2}$; $42(2) = (x+8)(7)$; $84 = 7x + 56$; $7x = 28$; $x = 4$ 11. $\frac{9}{13} = \frac{y}{65}$; $9(65) = 13y$; $585 = 13y$; $y = 45$ 12. $\frac{6}{x-5} = \frac{1}{2}$; $6(2) = (x-5)(1)$; $12 = x-5$; $x = 17$ 13. $\frac{3n-1}{14} = \frac{4}{7}$; $(3n-1)(7) = 14(4)$; $21n-7 = 56$; $21n = 63$; $n = 3$ 14. $\frac{4}{33} = \frac{8}{w}$; $4w = 33(8)$; $4w = 264$; $w = 66$ 15. $\frac{y-1}{5} = \frac{y+3}{7}$; $(y-1)(7) = 5(y+3)$; $7y-7 = 5y+15$; $2y = 22$; $y = 11$ 16. $\sqrt{4} = 2$ 17. $\sqrt{225} = 15$ 18. $\sqrt{\frac{9}{25}} = \sqrt{\frac{1}{5}}$ 19. $-\sqrt{0.0036} = -0.06$ 20. $\sqrt{40} \approx 6.32$ 21. $\sqrt{84} \approx 9.17$ 22. $\sqrt{104} \approx 10.20$ 23. $\sqrt{3.2} \approx 1.79$ 24. $x^2 + 6x + 1 = 0$; $b^2 - 4ac = 6^2 - 4(1)(1) = 36 - 4 = 32 > 0$; 2 real solutions 25. $x^2 - 5x - 6 = 0$; $b^2 - 4ac = (-5)^2 - 4(1)(-6) = 25 - (-24) = 49 > 0$; 2 real solutions 26. $x^2 - 2x + 9 = 0$; $b^2 - 4ac = (-2)^2 - 4(1)(9) = 4 - 36 = -32 < 0$; 0 real solutions 27. $4x^2 - 4x = -1$; $4x^2 - 4x + 1 = 0$; $b^2 - 4ac = (-4)^2 - 4(4)(1) = 16 - 16 = 0$; 1 real solution 28. $6x^2 + 5x - 2 = -3$; $6x^2 + 5x + 1 = 0$; $b^2 - 4ac = 5^2 - 4(6)(1) = 25 - 24 = 1 > 0$; 2 real solutions 29. $(2x-5)^2 = 121$; $4x^2 - 20x + 25 = 121$; $4x^2 - 20x - 96 = 0$; $b^2 - 4ac = (-20)^2 - 4(4)(-96) = 400 - (-1536) = 1936 > 0$; 2 real solutions

11-1 Simplifying Radicals

pages 578–583

Check Skills You'll Need For complete solutions see *Daily Skills Check and Lesson Quiz Transparencies* or *Presentation Pro CD-ROM*.

1. 1 2. 1 3. 3 4. 4 5. 2 6. 13 7. 5 8. 7

Check Understanding 1a. $\sqrt{50} = \sqrt{25 \cdot 2} = \sqrt{25} \cdot \sqrt{2} = 5\sqrt{2}$ 1b. $-5\sqrt{300} = -5\sqrt{100 \cdot 3} = -5 \cdot \sqrt{100} \cdot \sqrt{3} = -5 \cdot 10\sqrt{3} = -50\sqrt{3}$ 1c. $\sqrt{18} = \sqrt{9 \cdot 2} = \sqrt{9} \cdot \sqrt{2} = 3\sqrt{2}$ 2a. $\sqrt{27n^2} =$

- 2b. $-a\sqrt{60a^7} = -a\sqrt{4a^6 \cdot 15a} = -a\sqrt{4a^6} \cdot \sqrt{15a} = -a \cdot 2a^3 \cdot \sqrt{15a} = -2a^4\sqrt{15a}$ 2c. $\sqrt{x^2y^5} = \sqrt{x^2y^4 \cdot y} = \sqrt{x^2y^4} \cdot \sqrt{y} = xy^2\sqrt{y}$ 3a. $\sqrt{13} \cdot \sqrt{52} = \sqrt{13 \cdot 52} = \sqrt{676} = 26$ 3b. $5\sqrt{3c} \cdot \sqrt{6c} = 5\sqrt{3c \cdot 6c} = 5\sqrt{18c^2} = 5\sqrt{9c^2 \cdot 2} = 5 \cdot \sqrt{9c^2} \cdot \sqrt{2} = 5 \cdot 3c \cdot \sqrt{2} = 15c\sqrt{2}$ 3c. $2\sqrt{5a^2} \cdot 6\sqrt{10a^3} = 2 \cdot 6 \cdot \sqrt{5a^2 \cdot 10a^3} = 12\sqrt{50a^5} = 12\sqrt{25a^4 \cdot 2a} = 12\sqrt{25a^4} \cdot \sqrt{2a} = 12 \cdot 5a^2 \cdot \sqrt{2a} = 60a^2\sqrt{2a}$ 4. d. $\sqrt{1.5h} = \sqrt{1.5 \cdot 25} = \sqrt{37.5} \approx 6$; about 6 mi 5a. $\sqrt{\frac{144}{9}} = \frac{\sqrt{144}}{\sqrt{9}} = \frac{12}{3} = 4$ 5b. $\sqrt{\frac{25p^3}{q^2}} = \frac{\sqrt{25p^3}}{\sqrt{q^2}} =$ $\frac{\sqrt{25p^2} \cdot p}{\sqrt{q^2}} = \frac{\sqrt{25p^2} \cdot \sqrt{p}}{\sqrt{q^2}} = \frac{5p\sqrt{p}}{q}$ 5c. $\sqrt{\frac{75}{16t^2}} = \frac{\sqrt{75}}{\sqrt{16t^2}} = \frac{\sqrt{75}}{\sqrt{16t^2}} = \frac{\sqrt{25 \cdot 3}}{\sqrt{16t^2}} = \frac{\sqrt{25} \cdot \sqrt{3}}{\sqrt{16t^2}} = \frac{5\sqrt{3}}{4t}$ 6a. $\sqrt{\frac{90}{5}} = \sqrt{18} = \sqrt{9 \cdot 2} = \sqrt{9} \cdot \sqrt{2} = 3\sqrt{2}$ 6b. $\sqrt{\frac{48}{75}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$ 6c. $\sqrt{\frac{27x^3}{3x}} = \sqrt{9x^2} = 3x$ 7a. $\frac{3}{\sqrt{3}} = \frac{3 \cdot \sqrt{3}}{\sqrt{3} \cdot \sqrt{3}} = \frac{3\sqrt{3}}{3} = \sqrt{3}$ 7b. $\frac{\sqrt{5}}{\sqrt{18t}} = \frac{\sqrt{5} \cdot \sqrt{2t}}{\sqrt{2t} \cdot \sqrt{36t^2}} = \frac{\sqrt{10t}}{6t}$ 7c. $\sqrt{\frac{7m}{10}} = \frac{\sqrt{7m}}{\sqrt{10}} \cdot \frac{\sqrt{10}}{\sqrt{10}} = \frac{\sqrt{70m}}{10}$ Exercises 1. $\sqrt{200} = \sqrt{100 \cdot 2} = \sqrt{100} \cdot \sqrt{2} = 10\sqrt{2}$ 2. $\sqrt{98} = \sqrt{49 \cdot 2} = \sqrt{49} \cdot \sqrt{2} = 7\sqrt{2}$ 3. $\sqrt{75} = \sqrt{25 \cdot 3} = \sqrt{25} \cdot \sqrt{3} = 5\sqrt{3}$ 4. $-\sqrt{80} = -\sqrt{16 \cdot 5} = -\sqrt{16} \cdot \sqrt{5} = -4\sqrt{5}$ 5. $-3\sqrt{120} = -3\sqrt{4 \cdot 30} = -3\sqrt{4} \cdot \sqrt{30} = -3(2) \cdot \sqrt{30} = -6\sqrt{30}$ 6. $5\sqrt{320} = 5\sqrt{64 \cdot 5} = 5\sqrt{64} \cdot \sqrt{5} = 5(8) \cdot \sqrt{5} = 40\sqrt{5}$ 7. $\sqrt{28n^2} = \sqrt{4n^2 \cdot 7} = \sqrt{4n^2} \cdot \sqrt{7} = 2n\sqrt{7}$ 8. $\sqrt{108b^4} = \sqrt{36b^4 \cdot 3} = \sqrt{36b^4} \cdot \sqrt{3} = 6b^2\sqrt{3}$ 9. $3\sqrt{12x^2} = 3\sqrt{4x^2} \cdot \sqrt{3} = 3(2x) \cdot \sqrt{3} = 6x\sqrt{3}$ 10. $\sqrt{4n^3} = \sqrt{4n^2 \cdot n} = \sqrt{4n^2} \cdot \sqrt{n} = 2n\sqrt{n}$ 11. $\sqrt{20a^5} = \sqrt{4a^4 \cdot 5a} = \sqrt{4a^4} \cdot \sqrt{5a} = 2a^2\sqrt{5a}$ 12. $-\sqrt{48b^4} = -\sqrt{16b^4 \cdot 3} = -\sqrt{16b^4} \cdot \sqrt{3} = -4b^2\sqrt{3}$ 13. $\sqrt{10} \cdot \sqrt{40} = \sqrt{10 \cdot 40} = \sqrt{400} = 20$ 14. $3\sqrt{6} \cdot \sqrt{6} = 3\sqrt{6 \cdot 6} = 3\sqrt{36} = 3(6) = 18$ 15. $\sqrt{22} \cdot \sqrt{11} = \sqrt{242} = \sqrt{121 \cdot 2} = \sqrt{121} \cdot \sqrt{2} = 11\sqrt{2}$ 16. $2\sqrt{18} \cdot 7\sqrt{6} = 2(7) \cdot \sqrt{18 \cdot 6} = 14\sqrt{108} = 14\sqrt{36 \cdot 3} = 14\sqrt{36} \cdot \sqrt{3} = 14(6) \cdot \sqrt{3} = 84\sqrt{3}$ 17. $\sqrt{7} \cdot \sqrt{21} = \sqrt{147} = \sqrt{49 \cdot 3} = \sqrt{49} \cdot \sqrt{3} = 7\sqrt{3}$ 18. $-3\sqrt{20} \cdot \sqrt{15} =$

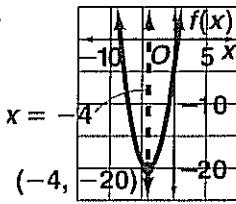
- $-3\sqrt{20 \cdot 15} = -3\sqrt{300} = -3\sqrt{100 \cdot 3} =$
 $-3\sqrt{100} \cdot \sqrt{3} = -3(10) \cdot \sqrt{3} = -30\sqrt{3}$
19. $\sqrt{3n} \cdot \sqrt{24n} = \sqrt{72n^2} = \sqrt{36n^2 \cdot 2} =$
 $\sqrt{36n^2} \cdot \sqrt{2} = 6n\sqrt{2}$ **20.** $2\sqrt{7t} \cdot \sqrt{14t} = 2\sqrt{98t^2} =$
 $2\sqrt{49t^2 \cdot 2} = 2\sqrt{49t^2} \cdot \sqrt{2} = 2(7t) \cdot \sqrt{2} = 14t\sqrt{2}$
21. $\sqrt{3x} \cdot \sqrt{51x^3} = \sqrt{153x^4} = \sqrt{9x^4 \cdot 17} =$
 $\sqrt{9x^4} \cdot \sqrt{17} = 3x^2\sqrt{17}$ **22.** $5\sqrt{8t} \cdot \sqrt{32t^5} =$
 $5\sqrt{256t^6} = 5(16t^3) = 80t^3$ **23.** $\sqrt{2a^2} \cdot \sqrt{9a^4} =$
 $\sqrt{18a^6} = \sqrt{9a^6} \cdot 2 = \sqrt{9a^6} \cdot \sqrt{2} = 3a^3\sqrt{2}$
24. $-2\sqrt{6a^3} \cdot \sqrt{3a} = -2\sqrt{18a^4} = -2\sqrt{9a^4 \cdot 2} =$
 $-2\sqrt{9a^4} \cdot \sqrt{2} = -2(3a^2) \cdot \sqrt{2} = -6a^2\sqrt{2}$
25. $d = \sqrt{1.5h} = \sqrt{1.5 \cdot 6} = \sqrt{9} = 3$; 3 mi
26. $d = \sqrt{1.5h} = \sqrt{1.5 \cdot 100} = \sqrt{150} \approx 12$;
about 12 mi **27.** $d = \sqrt{1.5h} = \sqrt{1.5 \cdot 200} =$
 $\sqrt{300} \approx 17$; about 17 mi **28.** $\sqrt{\frac{21}{49}} = \frac{\sqrt{21}}{\sqrt{49}} = \frac{\sqrt{21}}{7}$
29. $3\sqrt{\frac{3}{4}} = \frac{3\sqrt{3}}{\sqrt{4}} = \frac{3\sqrt{3}}{2}$ **30.** $\sqrt{\frac{625}{100}} = \frac{\sqrt{625}}{\sqrt{100}} = \frac{25}{10} = \frac{5}{2}$
31. $\sqrt{\frac{120}{121}} = \frac{\sqrt{120}}{\sqrt{121}} = \frac{\sqrt{4 \cdot 30}}{\sqrt{121}} = \frac{\sqrt{4} \cdot \sqrt{30}}{\sqrt{121}} = \frac{2\sqrt{30}}{11}$
32. $\sqrt{\frac{5}{9a^2}} = \frac{\sqrt{5}}{\sqrt{9a^2}} = \frac{\sqrt{5}}{3a}$ **33.** $\sqrt{\frac{7}{16c^2}} = \frac{7}{\sqrt{16c^2}} = \frac{\sqrt{7}}{4c}$
34. $\sqrt{\frac{75a}{49}} = \frac{\sqrt{75a}}{\sqrt{49}} = \frac{\sqrt{25 \cdot 3a}}{\sqrt{49}} = \frac{\sqrt{25} \cdot \sqrt{3a}}{\sqrt{49}} = \frac{5\sqrt{3a}}{7}$
35. $\sqrt{\frac{8n^3}{81}} = \frac{\sqrt{8n^3}}{\sqrt{81}} = \frac{\sqrt{4n^2 \cdot 2n}}{\sqrt{81}} = \frac{\sqrt{4n^2} \cdot \sqrt{2n}}{\sqrt{81}} = \frac{2n\sqrt{2n}}{9}$
36. $\sqrt{\frac{15}{5}} = \sqrt{3}$ **37.** $\sqrt{\frac{54}{24}} = \sqrt{\frac{9}{4}} = \frac{\sqrt{9}}{\sqrt{4}} = \frac{3}{2}$ **38.** $\sqrt{\frac{60}{5}} =$
 $\sqrt{12} = \sqrt{4 \cdot 3} = \sqrt{4} \cdot \sqrt{3} = 2\sqrt{3}$ **39.** $-\sqrt{\frac{160}{8}} =$
 $-\sqrt{20} = -\sqrt{4 \cdot 5} = -\sqrt{4} \cdot \sqrt{5} = -2\sqrt{5}$
40. $\sqrt{\frac{140x^3}{5x}} = \sqrt{28x^2} = \sqrt{4x^2 \cdot 7} = \sqrt{4x^2} \cdot \sqrt{7} =$
 $2x\sqrt{7}$ **41.** $\sqrt{\frac{3x^3}{27s}} = \sqrt{\frac{s^2}{9}} = \frac{\sqrt{s^2}}{\sqrt{9}} = \frac{s}{3}$ **42.** $\sqrt{\frac{30a^5}{40a}} =$
 $\sqrt{\frac{3a^4}{4}} = \frac{\sqrt{a^4 \cdot 3}}{\sqrt{4}} = \frac{\sqrt{a^4} \cdot \sqrt{3}}{\sqrt{4}} = \frac{a^2\sqrt{3}}{2}$ **43.** $\sqrt{\frac{63y}{7y^3}} =$
 $\sqrt{\frac{9}{y^2}} = \frac{\sqrt{9}}{\sqrt{y^2}} = \frac{3}{y}$ **44.** $\frac{3}{\sqrt{2}} = \frac{3}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{3\sqrt{2}}{\sqrt{4}} = \frac{3\sqrt{2}}{2}$
45. $\frac{5}{\sqrt{5}} = \frac{5}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{5\sqrt{5}}{5} = \sqrt{5}$ **46.** $\frac{\sqrt{3}}{\sqrt{7x}} =$
 $\frac{\sqrt{3} \cdot \sqrt{7x}}{\sqrt{7x} \cdot \sqrt{7x}} = \frac{\sqrt{21x}}{\sqrt{49x^2}} = \frac{\sqrt{21x}}{7x}$ **47.** $\frac{2\sqrt{2}}{\sqrt{5n}} = \frac{2\sqrt{2}}{\sqrt{5n}} \cdot \frac{\sqrt{5n}}{\sqrt{5n}} =$
 $\frac{2\sqrt{10n}}{5n}$ **48.** $\frac{9}{\sqrt{8}} = \frac{9}{\sqrt{8}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{9\sqrt{2}}{\sqrt{16}} = \frac{9\sqrt{2}}{4}$
49. $\frac{12}{\sqrt{12}} = \frac{12}{\sqrt{12}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{12\sqrt{3}}{\sqrt{36}} = \frac{12\sqrt{3}}{6} = 2\sqrt{3}$
50. $\frac{3\sqrt{2}}{\sqrt{9b}} = \frac{3\sqrt{2}}{\sqrt{9b}} \cdot \frac{\sqrt{b}}{\sqrt{b}} = \frac{3\sqrt{2b}}{\sqrt{9b^2}} = \frac{3\sqrt{2b}}{3b} = \frac{\sqrt{2b}}{b}$
51. $\frac{5\sqrt{11}}{\sqrt{20y}} = \frac{5\sqrt{11}}{\sqrt{20y}} \cdot \frac{\sqrt{5y}}{\sqrt{5y}} = \frac{5\sqrt{55y}}{\sqrt{100y^2}} = \frac{5\sqrt{55y}}{10y} = \frac{\sqrt{55y}}{2y}$
52. not simplest form; radical in the denominator of a fraction **53.** not simplest form; radical in the denominator of a fraction **54.** Simplest form; radicand has no perfect-square factors other than 1. **55.** Simplest form; radicand has no perfect-square factors other than 1. **56a.** $\sqrt{18 \cdot 10} = \sqrt{180} = \sqrt{36} \cdot \sqrt{5} = 6\sqrt{5}$

- 56b.** Answers may vary. Sample: $a = 36, b = 5; a = 9, b = 20$
- 57.** $\sqrt{12} \cdot \sqrt{75} = \sqrt{900} = 30$ **58.** $\sqrt{26 \cdot 2} = \sqrt{52} = \sqrt{4 \cdot 13} = \sqrt{4} \cdot \sqrt{13} = 2\sqrt{13}$ **59.** $\frac{\sqrt{72}}{\sqrt{64}} = \frac{\sqrt{36} \cdot \sqrt{2}}{8} = \frac{6\sqrt{2}}{8} = \frac{3\sqrt{2}}{4}$ **60.** $\frac{-2}{\sqrt{a^3}} = \frac{-2\sqrt{a}}{\sqrt{a^3} \cdot \sqrt{a}} = \frac{-2\sqrt{a}}{a^2}$ **61.** $\frac{\sqrt{180}}{\sqrt{3}} = \sqrt{\frac{180}{3}} = \sqrt{60} = \sqrt{4 \cdot 15} = \sqrt{4} \cdot \sqrt{15} = 2\sqrt{15}$ **62.** $\frac{\sqrt{x^2}}{\sqrt{y^3}} = \frac{\sqrt{x^2}y}{\sqrt{y^3} \cdot \sqrt{y}} = \frac{x\sqrt{y}}{y^2}$ **63.** $\frac{-3\sqrt{2}}{\sqrt{6}} = \frac{-3\sqrt{2}}{\sqrt{6}} \cdot \frac{\sqrt{6}}{\sqrt{6}} = \frac{-3\sqrt{12}}{6} = \frac{-\sqrt{4} \cdot \sqrt{3}}{2} = \frac{-2\sqrt{3}}{2} = -\sqrt{3}$
64. $\sqrt{8} \cdot \sqrt{10} = \sqrt{8 \cdot 10} = \sqrt{80} = \sqrt{16 \cdot 5} = \sqrt{16} \cdot \sqrt{5} = 4\sqrt{5}$ **65.** $\sqrt{20a^2b^3} = \sqrt{4a^2b^2 \cdot 5b} = \sqrt{4a^2b^2} \cdot \sqrt{5b} = 2ab\sqrt{5b}$ **66.** $\sqrt{a^3b^5c^3} = \sqrt{a^2b^4c^2 \cdot abc} = \sqrt{a^2b^4c^2} \cdot \sqrt{abc} = ab^2c\sqrt{abc}$
67. $\sqrt{\frac{3m}{16m^2}} = \frac{\sqrt{3m}}{\sqrt{16m^2}} = \frac{\sqrt{3m}}{4m}$ **68.** $\frac{16a}{\sqrt{6a^3}} = \frac{16a}{\sqrt{6a^3} \cdot \sqrt{6a}} = \frac{16a\sqrt{6a}}{\sqrt{36a^4}} = \frac{16a\sqrt{6a}}{6a^2} = \frac{8\sqrt{6a}}{3a}$
69. $x^2 + 6x - 9 = 0; a = 1, b = 6, c = -9; x =$
 $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-6 \pm \sqrt{6^2 - 4(1)(-9)}}{2(1)} = \frac{-6 \pm \sqrt{72}}{2} =$
 $\frac{-6 \pm 6\sqrt{2}}{2} = -3 \pm 3\sqrt{2}$ **70.** $n^2 - 2n + 1 = 5;$
 $n^2 - 2n - 4 = 0; a = 1, b = -2, c = -4; x =$
 $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(-4)}}{2(1)} =$
 $\frac{2 \pm \sqrt{20}}{20} = \frac{2 \pm 2\sqrt{5}}{2} = 1 \pm \sqrt{5}$ **71.** $3y^2 - 4y - 2 = 0;$
 $a = 3, b = -4, c = -2; x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} =$
 $\frac{-(-4) \pm \sqrt{(-4)^2 - 4(3)(-2)}}{2(3)} = \frac{4 \pm \sqrt{40}}{6} = \frac{4 \pm 2\sqrt{10}}{6} =$
 $\frac{2 \pm \sqrt{10}}{3}$ **72a.** $\sqrt{50} = \sqrt{25 \cdot 2} = \sqrt{25} \cdot \sqrt{2} = 5\sqrt{2}$
72b. The radicand has no perfect-square factors other than 1. **73.** Answers may vary. Sample: 12, 27, 48
74a. $\sqrt{24} = \sqrt{4 \cdot 6} = \sqrt{4} \cdot \sqrt{6} = 2\sqrt{6}$; 2 $\sqrt{6}$ in. **74b.** $2\sqrt{6} \approx 4.90$; 4.90 in. **75.** $\sqrt{24} \cdot \sqrt{2x} \cdot \sqrt{3x} =$
 $\sqrt{144x^2} = 12x$ **76.** $2b(\sqrt{5b})^2 = 2b(5b) = 10b^2$
77. $\sqrt{45a^7} \cdot \sqrt{20a} = \sqrt{900a^8} = 30a^4$ **78.** $T =$
 $2\pi\sqrt{\frac{L}{32}} = 2\pi\sqrt{\frac{8}{32}} = 2\pi\sqrt{\frac{1}{4}} = 2\pi\left(\frac{1}{2}\right) = \pi$; π seconds
79. $\sqrt{80} = \sqrt{16 \cdot 5} = \sqrt{16} \cdot \sqrt{5} = 4\sqrt{5}$; C
80. $5\sqrt{3x^2} \cdot \sqrt{6x} = 5\sqrt{18x^3} = 5\sqrt{9x^2 \cdot 2x} =$
 $5\sqrt{9x^2} \cdot \sqrt{2x} = 5(3x) \cdot \sqrt{2x} = 15x\sqrt{2x}$; F
81. $\sqrt{\frac{6}{9}} = \sqrt{\frac{2}{3}} \neq \frac{2}{3}; \sqrt{\frac{20}{45}} = \sqrt{\frac{4}{9}} = \frac{\sqrt{4}}{\sqrt{9}} = \frac{2}{3}; \sqrt{\frac{9}{25}} =$
 $\frac{\sqrt{9}}{\sqrt{25}} = \frac{3}{5} \neq \frac{2}{3}; 2\sqrt{\frac{4}{27}} = \frac{2\sqrt{4}}{\sqrt{27}} = \frac{2(2)}{\sqrt{27}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{4\sqrt{3}}{\sqrt{81}} =$
 $\frac{4\sqrt{3}}{9} \neq \frac{2}{3}$; B **82.** $1.5\sqrt{0.038} = 1.5 \cdot \sqrt{\frac{3.8}{100}} =$
 $1.5 \cdot \frac{\sqrt{3.8}}{\sqrt{100}} = \frac{1.5\sqrt{3.8}}{10} = 0.15\sqrt{3.8}$, so eliminate choices F and H; $1.5\sqrt{0.038} = 1.5\sqrt{0.00038 \cdot 100} =$
 $1.5\sqrt{100} \cdot \sqrt{0.00038} = 1.5(10)\sqrt{0.00038} =$

$15\sqrt{0.00038}$; I 83. [2] $A = 96 \text{ ft}^2$; $s = \sqrt{96} = \sqrt{16 \cdot 6} = \sqrt{16} \cdot \sqrt{6} = 4\sqrt{6} \text{ ft}$ [1] correct answer, without work shown 84. The data appear to be quadratic, so test for a common second difference: $0 - 0.2 = -0.2$, $0.2 - 0 = 0.2$, $0.8 - 0.2 = 0.6$, $1.8 - 0.8 = 1.0$, $3.2 - 1.8 = 1.4$, and $0.2 - (-0.2) = 0.4$, $0.6 - 0.2 = 0.4$, $1.0 - 0.6 = 0.4$, $1.4 - 1.0 = 0.4$; common second difference is 0.4, so the function is quadratic; $y = 0.2x^2$ 85. The data appear to be exponential, so test for a common ratio: $4 \div 1.6 = 2.5$, $10 \div 4 = 2.5$, $25 \div 10 = 2.5$, $62.5 \div 25 = 2.5$,

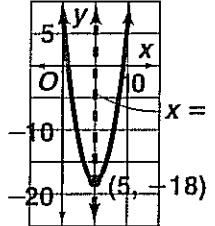
$156.25 \div 62.5 = 2.5$; common ratio is 2.5, so the function is exponential; $y = 4(2.5)^x$ 86. The data appear to be linear, so test for a common difference: $7 - 11.2 = -4.2$, $2.8 - 7 = -4.2$, $-1.4 - 2.8 = -4.2$, $-5.6 - (-1.4) = -4.2$, $-9.8 - (-5.6) = -4.2$; common difference is -4.2, so the function is linear; $y = -4.2x + 7$

87.



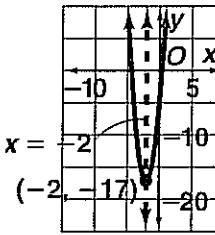
$$f(x) = x^2 + 8x - 4; \text{ axis of symmetry: } x = -\frac{b}{2a} = -\frac{8}{2(1)} = -4; \text{ y-coordinate of vertex: } y = (-4)^2 + 8(-4) - 4 = -20; \text{ vertex } (-4, -20); \text{ points } (0, -4), (1, 5)$$

88.



$$y = x^2 - 10x + 7; \text{ axis of symmetry: } x = -\frac{b}{2a} = -\frac{-10}{2(1)} = 5; \text{ y-coordinate of vertex: } y = 5^2 - 10(5) + 7 = -18; \text{ vertex } (5, -18); \text{ points } (0, 7), (2, -9)$$

89.



$$y = 3x^2 + 12x - 5; \text{ axis of symmetry: } x = -\frac{b}{2a} = -\frac{12}{2(3)} = -2; \text{ y-coordinate of vertex: } y = 3(-2)^2 + 12(-2) - 5 = -17; \text{ vertex } (-2, -17); \text{ points } (0, -5), (-5, 7)$$

90. $(n^2 + 5n - 1) + (2n^2 + 6) = (n^2 + 2n^2) + 5n + (-1 + 6) = 3n^2 + 5n + 5$

91. $(4v^2 + 8v - 2) - (v^2 + 9v + 7) = (4v^2 - v^2) + (8v - 9v) + (-2 - 7) = 3v^2 - v - 9$

92. $(5t^3 - 14t) + (8t^2 - 11) = 5t^3 + 8t^2 - 14t - 11$

93. $(2b^2 - 12b - 8) - (5b^2 + 11b + 13) = (2b^2 - 5b^2) + (-12b - 11b) + (-8 - 13) = -3b^2 - 23b - 21$

Investigation

1.

a	b	c	a^2	b^2	$a^2 + b^2$	c^2
3	4	5	9	16	25	25
5	12	13	25	144	169	169
$\frac{3}{5}$	$\frac{4}{5}$	1	$\frac{9}{25}$	$\frac{16}{25}$	1	1
0.9	1.2	1.5	0.81	1.44	2.25	2.25

2. The sum $a^2 + b^2$ is equal to c^2 . 3. For a right triangle, the square of the longest side equals the sum of the squares of the other two sides.

Check Understanding 1. $a^2 + b^2 = c^2$; $7^2 + 24^2 = c^2$;

$$49 + 576 = c^2; 625 = c^2; \sqrt{625} = \sqrt{c^2}; c = 25; 25 \text{ cm}$$

2. $a^2 + b^2 = c^2$; $4^2 + b^2 = 8^2$; $16 + b^2 = 64$; $b^2 = 48$;

$$\sqrt{b^2} = \sqrt{48}; b \approx 6.9; \text{ about } 6.9 \text{ mi}$$
 3. $10^2 + 24^2 \leq 26^2$;
 $100 + 576 \leq 676$; $676 = 676$; yes
 $4. 60^2 + 70^2 \leq 100^2$;
 $3600 + 4900 \leq 10,000$; $8500 \neq 10,000$; no

Exercises 1. $a^2 + b^2 = c^2$; $6^2 + 8^2 = c^2$; $36 + 64 = c^2$;

$$100 = c^2; \sqrt{100} = \sqrt{c^2}; c = 10$$
 2. $a^2 + b^2 = c^2$;
 $15^2 + 20^2 = c^2$; $225 + 400 = c^2$; $625 = c^2$; $\sqrt{625} = \sqrt{c^2}$;
 $c = 25$
 3. $a^2 + b^2 = c^2$; $8^2 + 15^2 = c^2$; $64 + 225 = c^2$;
 $289 = c^2$; $\sqrt{289} = \sqrt{c^2}$; $c = 17$
 4. $a^2 + b^2 = c^2$;
 $10^2 + 24^2 = c^2$; $100 + 576 = c^2$; $\sqrt{676} = \sqrt{c^2}$;
 $c = 26$
 5. $a^2 + b^2 = c^2$; $1.5^2 + 2^2 = c^2$; $2.25 + 4 = c^2$;
 $6.25 = c^2$; $\sqrt{6.25} = \sqrt{c^2}$; $c = 2.5$
 6. $a^2 + b^2 = c^2$;
 $(\frac{3}{5})^2 + (\frac{4}{5})^2 = c^2$; $\frac{9}{25} + \frac{16}{25} = c^2$; $1 = c^2$; $\sqrt{1} = \sqrt{c^2}$; $c = 1$
 7. $a^2 + b^2 = c^2$; $3^2 + b^2 = 5^2$; $9 + b^2 = 25$; $b^2 = 16$;
 $\sqrt{b^2} = \sqrt{16}$; $b = 4$
 8. $a^2 + b^2 = c^2$; $a^2 + 12^2 = 13^2$;
 $a^2 + 144 = 169$; $a^2 = 25$; $\sqrt{a^2} = \sqrt{25}$; $a = 5$
 9. $a^2 + b^2 = c^2$; $9^2 + b^2 = 15^2$; $81 + b^2 = 225$; $b^2 = 144$;
 $\sqrt{b^2} = \sqrt{144}$; $b = 12$
 10. $a^2 + b^2 = c^2$; $a^2 + 7^2 = 10^2$;
 $a^2 + 49 = 100$; $a^2 = 51$; $\sqrt{a^2} = \sqrt{51}$; $a \approx 7.1$
 11. $a^2 + b^2 = c^2$; $5^2 + b^2 = 9^2$; $25 + b^2 = 81$; $b^2 = 56$;
 $\sqrt{b^2} = \sqrt{56}$; $b \approx 7.5$
 12. $a^2 + b^2 = c^2$; $0.8^2 + b^2 = 1^2$;
 $0.64 + b^2 = 1$; $b^2 = 0.36$; $\sqrt{b^2} = \sqrt{0.36}$; $b = 0.6$
 13. $w^2 + 1.6^2 = 2^2$; $w^2 + 2.56 = 4$; $w^2 = 1.44$; $\sqrt{w^2} = \sqrt{1.44}$; $w = 1.2$; 1.2 m
 14. $4^2 + x^2 = 16^2$; $16 + x^2 = 256$;
 $x^2 = 240$; $\sqrt{x^2} = \sqrt{240}$; $x \approx 15.5$; about 15.5 ft
 15. $5^2 + 3^2 = x^2$; $25 + 9 = x^2$; $34 = x^2$; $\sqrt{34} = \sqrt{x^2}$;
 $x \approx 5.8$; about 5.8 km
 16. $9^2 + 12^2 \leq 15^2$; $81 + 144 \leq 225$; $225 = 225$; yes
 17. $1^2 + 2^2 \leq 3^2$; $1 + 4 \leq 9$; $5 \neq 9$; no
 18. $2^2 + 4^2 \leq 5^2$; $4 + 16 \leq 25$; $20 \neq 25$; no
 19. $16^2 + 30^2 \leq 34^2$; $256 + 900 \leq 1156$; $1156 = 1156$; yes
 20. $4^2 + 4^2 \leq 8^2$; $16 + 16 \leq 64$; $32 \neq 64$; no
 21. $10^2 + 24^2 \leq 26^2$; $100 + 576 \leq 676$; $676 = 676$; yes
 22. $45^2 + 24^2 \leq 51^2$; $2025 + 576 \leq 2601$; $2601 = 2601$; yes
 23. $3.5^2 + 6.2^2 \leq 9.1^2$; $12.25 + 38.44 \leq 82.81$;
 $50.69 \neq 82.81$; no
 24. $20^2 + 10^2 \leq 30^2$; $400 + 100 \leq 900$; $500 \neq 900$; no
 25. $1.25^2 + 3^2 \leq 3.25^2$; $1.5625 + 9 \leq 10.5625$; $10.5625 = 10.5625$; yes
 26. $a^2 + b^2 = c^2$;
 $1.2^2 + 0.9^2 = c^2$; $1.44 + 0.81 = c^2$; $2.25 = c^2$;
 $\sqrt{2.25} = \sqrt{c^2}$;

11-2 The Pythagorean Theorem

pages 584–590

Check Skills You'll Need For complete solutions see Daily Skills Check and Lesson Quiz Transparencies or Presentation Pro CD-ROM.

1. 61 2. 65 3. 25^2 4. -6, 6 5. -5, 5 6. -7, 7

7. $-2\sqrt{5}, 2\sqrt{5}$ 8. $-4\sqrt{5}, 4\sqrt{5}$ 9. $-4\sqrt{3}, 4\sqrt{3}$

Algebra 1 Solution Key

• Chapter 11, page 246

- $\sqrt{c^2}; c = 1.5$ 27. $a^2 + b^2 = c^2; \left(\frac{1}{5}\right)^2 + b^2 = \left(\frac{1}{3}\right)^2;$
 $\frac{1}{25} + b^2 = \frac{1}{9}; b^2 = \frac{16}{225}; \sqrt{b^2} = \sqrt{\frac{16}{225}}; b = \frac{4}{15}$ or $b \approx 0.3$
28. $a^2 + b^2 = c^2; (\sqrt{5})^2 + b^2 = (\sqrt{14})^2; 5 + b^2 = 14;$
 $b^2 = 9; \sqrt{b^2} = \sqrt{9}; b = 3$ 29. $a^2 + b^2 = c^2;$
 $(\sqrt{7})^2 + (\sqrt{29})^2 = c^2; 7 + 29 = c^2; 36 = c^2; \sqrt{36} =$
 $\sqrt{c^2}; c = 6$ 30. $a^2 + b^2 = c^2; 2.4^2 + 1.0^2 = c^2; 5.76 + 1 =$
 $c^2; 6.76 = c^2; \sqrt{6.76} = \sqrt{c^2}; c = 2.6$ 31. $a^2 + b^2 = c^2;$
 $(2\frac{1}{2})^2 + (6\frac{1}{2})^2 = c^2; 6.25 + 42.25 = c^2; 48.5 = c^2;$
 $\sqrt{48.5} = \sqrt{c^2}; c \approx 7.0$ 32a. $12^2 + x^2 = 18^2; 144 + x^2 =$
 $324; x^2 = 180; \sqrt{x^2} = \sqrt{180}; x = \sqrt{180} = \sqrt{36 \cdot 5} =$
 $\sqrt{36} \cdot \sqrt{5} = 6\sqrt{5}; 6\sqrt{5}$ ft 32b. $A = \frac{1}{2}bh =$
 $\frac{1}{2} \cdot 12 \cdot 6\sqrt{5} = 36\sqrt{5} \approx 80.5$; about 80.5 ft²
33. $1^2 + (\sqrt{3})^2 \stackrel{?}{=} 2^2; 1 + 3 \stackrel{?}{=} 4; 4 = 4$; yes
34. $(\sqrt{2})^2 + (\sqrt{2})^2 \stackrel{?}{=} 4^2; 2 + 2 \stackrel{?}{=} 16; 4 \neq 16$; no
35. $(\sqrt{6.2})^2 + (\sqrt{2.8})^2 \stackrel{?}{=} 3^2; 6.2 + 2.8 \stackrel{?}{=} 9; 9 = 9$; yes
36. $(\frac{3}{4})^2 + 1^2 \stackrel{?}{=} (1\frac{1}{4})^2; \frac{9}{16} + 1 \stackrel{?}{=} \frac{25}{16}; \frac{25}{16} = \frac{25}{16}$; yes
37. $3^2 + 3^2 = x^2; 9 + 9 = x^2; 18 = x^2; \sqrt{18} = \sqrt{x^2};$
 $x \approx 4.2$; 4.2 cm 38. $600^2 + 800^2 = x^2;$
 $360,000 + 640,000 = x^2; 1,000,000 = x^2; \sqrt{1,000,000} =$
 $\sqrt{x^2}; x = 1000$; 1000 lb 39. $252^2 + 500^2 = z^2;$
 $63,504 + 250,000 = z^2; 313,504 = z^2; \sqrt{313,504} = \sqrt{z^2};$
 $z \approx 559.9$ 40. $x^2 + 9^2 = 12.7^2; x^2 + 81 = 161.29; x^2 =$
 $80.29; \sqrt{x^2} = \sqrt{80.29}; x \approx 9.0$ 41. $y^2 + 2.5^2 = 10^2;$
 $y^2 + 6.25 = 100; y^2 = 93.75; \sqrt{y^2} = \sqrt{93.75}; y = 9.7$
- 42a. These lengths could be two legs or one leg and the hypotenuse. 42b. two legs: $10^2 + 8^2 = x^2; 100 + 64 = x^2;$
 $164 = x^2; \sqrt{164} = \sqrt{x^2}; x \approx 12.8$; one leg and the hypotenuse: $x^2 + 8^2 = 10^2; x^2 + 64 = 100; x^2 = 36;$
 $\sqrt{x^2} = \sqrt{36}; x = 6$; about 12.8 in. or 6 in. 43a. $6^2 + 8^2 =$
 $36 + 64 = 100 = 10^2$
- 43b.
- | a | b | c |
|-----|-----|-----|
| 3 | 4 | 5 |
| 5 | 12 | 13 |
| 7 | 24 | 25 |
| 9 | 40 | 41 |
- Row 1: $3^2 + 4^2 = c^2; 9 + 16 = c^2;$
 $25 = c^2; c = 5$; Row 2: $5^2 + b^2 =$
 $13^2; 25 + b^2 = 169; b^2 = 144;$
 $b = 12$; Row 3: $a^2 + 24^2 = 25^2;$
 $a^2 + 576 = 625; a^2 = 49; a = 7$;
Row 4: $9^2 + 40^2 = c^2;$
 $81 + 1600 = c^2; 1681 = c^2; c = 41$

- 43c. Answers may vary. Sample: 10, 24, 26
- 44a. $w^2 + 13^2 = 14.7^2; w^2 + 169 = 216.09; w^2 = 47.09;$
 $\sqrt{w^2} = \sqrt{47.09}; w \approx 6.9$; about 6.9 ft 44b. $A = \ell w =$
 $13\sqrt{47.09} \approx 89.2$; about 89.2 ft² 44c. $11(89.2) = 981.2$;
about 981 watts 45. $8^2 + 10^2 = x^2; 64 + 100 = x^2; 164 =$
 $x^2; \sqrt{164} = \sqrt{x^2}; x \approx 12.8$; about 12.8 ft 46. Answers
may vary. Sample is given. 46a. $\sqrt{5}, \sqrt{20}, 5$ 46b. $A =$
 $\frac{1}{2}bh = \frac{1}{2} \cdot \sqrt{5} \cdot \sqrt{20} = \frac{1}{2}\sqrt{100} = \frac{1}{2}(10) = 5$; 5 units²
- 47a. $6^2 + 12^2 = d^2; 36 + 144 = d^2; 180 = d^2;$
 $\sqrt{180} = \sqrt{d^2}; d \approx 13.4$; about 13.4 ft 47b. $12^2 + 12^2 =$
 $d^2; 144 + 144 = d^2; 288 = d^2; \sqrt{288} = \sqrt{d^2}; d \approx 17.0$;

- about 17.0 ft 47c. $h^2 + 12^2 = 16^2; h^2 + 144 = 256;$
 $h^2 = 112; \sqrt{h^2} = \sqrt{112}; h \approx 10.6$ ft
- 47d. No; the hypotenuse d must be longer than each leg
48. hypothesis: an integer has 2 as a factor; conclusion: the integer is even; converse: If an integer is even, then it has 2 as a factor; true. 49. hypothesis: a figure is a square; conclusion: the figure is a rectangle; converse: If a figure is a rectangle, then the figure is a square; false.
50. hypothesis: you are in Brazil; conclusion: you are south of the equator; converse: If you are south of the equator, then you are in Brazil; false. 51. hypothesis: an angle is a right angle; conclusion: its measure is 90°; converse: If the measure of an angle is 90°, then it is a right angle; true. 52. $4^2 + 6^2 = x^2; 16 + 36 = x^2; 52 = x^2;$
 $\sqrt{52} = \sqrt{x^2}; x = \sqrt{52}$; Area = $(\sqrt{52})^2 = 52$; 52 units²
53. $x^2 + x^2 = (6\sqrt{2})^2; 2x^2 = 72; x^2 = 36; \sqrt{x^2} = \sqrt{36};$
 $x = 6$; 6 in. 54. $s^2 + 15^2 = (5\sqrt{13})^2; s^2 + 225 = 325;$
 $s^2 = 100; \sqrt{s^2} = \sqrt{100}; s = 10$ 55. $s^2 + 6^2 = (2\sqrt{21})^2;$
 $s^2 + 36 = 84; s^2 = 48; \sqrt{s^2} = \sqrt{48}; s = \sqrt{48} =$
 $\sqrt{16 \cdot 3} = 4\sqrt{3}$ 56. Let $DB = x; x^2 + 3^2 = (\sqrt{10})^2;$
 $x^2 + 9 = 10; x^2 = 1; \sqrt{x^2} = \sqrt{1}; x = 1$; $AB = 3 + 1 = 4$;
 $4^2 + 3^2 = s^2; 16 + 9 = s^2; 25 = s^2; \sqrt{25} = \sqrt{s^2}; s = 5$
57. $n^2 + (n+1)^2 = (n+2)^2; n^2 + n^2 + 2n + 1 =$
 $n^2 + 4n + 4; n^2 - 2n - 3 = 0; (n-3)(n+1) = 0$;
 $n-3 = 0$ or $n+1 = 0$; $n = 3$ or $n = -1$; the integers are 3, 4, and 5.
- 58a.
-
- 58b. $5^2 + 7^2 = x^2; 25 + 49 = x^2;$
 $74 = x^2; \sqrt{74} = \sqrt{x^2}; x = \sqrt{74}$
- 59a. $(a+b)^2 = a^2 + 2ab + b^2$
- 59b. c^2 59c. $\frac{1}{2}ab$, or $\frac{ab}{2}$
- 59d. $(a+b)^2 = c^2 + 4\left(\frac{1}{2}ab\right);$
 $a^2 + 2ab + b^2 = c^2 + 2ab; a^2 + b^2 = c^2$ 59e. This equation is the same as the Pythagorean Theorem.
60. $8.4^2 + 7.6^2 = x^2; 70.56 + 57.76 = x^2; 128.32 = x^2;$
 $\sqrt{128.32} = \sqrt{x^2}; x \approx 11.33$; D 61. $x^2 + (2\sqrt{3})^2 =$
 $(3\sqrt{3})^2; x^2 + 12 = 27; x^2 = 15; \sqrt{x^2} = \sqrt{15}; x = \sqrt{15}$; H
62. In column A, $b < c$, so $b < 10$; in column B, $c > b$, so $c > 10$; the answer is B. 63. In column A, $a = 15$ and $b = 11$; in column B, $a = 11$ and $b = 15$; the c values will be equal, so the answer is C. 64. Column A: $a^2 + 10^2 = 22^2$;
 $a^2 + 100 = 484; a^2 = 384; \sqrt{a^2} = \sqrt{384}; a \approx 19.6$;
Column B: $a^2 + 12^2 = 20^2; a^2 + 144 = 400; a^2 = 256$;
 $\sqrt{a^2} = \sqrt{256}; a = 16$; $19.6 > 16$, so the answer is A.
65. [2] It is a right triangle. Substitute 17, the longest side, for c and substitute the other lengths for a and b in the Pythagorean Theorem. $8^2 + 15^2 \stackrel{?}{=} 17^2$;
 $64 + 225 \stackrel{?}{=} 289$; $289 = 289$ ✓ [1] incorrect equation
- OR incorrect explanation 66. $\sqrt{8} \cdot \sqrt{6} = \sqrt{8 \cdot 6} =$
 $\sqrt{48} = \sqrt{16 \cdot 3} = \sqrt{16} \cdot \sqrt{3} = 4\sqrt{3}$
67. $\frac{\sqrt{12}}{\sqrt{18}} = \frac{\sqrt{12}}{\sqrt{18}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{24}}{\sqrt{36}} = \frac{\sqrt{4 \cdot 6}}{6} = \frac{2\sqrt{6}}{6} = \frac{\sqrt{6}}{3}$

68. $\sqrt{5 \cdot 10} = \sqrt{50} = \sqrt{25 \cdot 2} = \sqrt{25} \cdot \sqrt{2} = 5\sqrt{2}$
 69. $\sqrt{40b^5} = \sqrt{4b^4 \cdot 10b} = \sqrt{4b^4} \cdot \sqrt{10b} = 2b^2\sqrt{10b}$
 70. $\frac{\sqrt{2x^2}}{\sqrt{4x^6}} = \frac{x\sqrt{2}}{2x^3} = \frac{\sqrt{2}}{2x^2}$ 71. $\sqrt{\frac{24v}{v^8}} = \frac{\sqrt{24v}}{v^4} = \frac{\sqrt{4 \cdot 6v}}{v^4} = \frac{2\sqrt{6v}}{v^4}$ 72. $\sqrt{9} < \sqrt{11} < \sqrt{16}$, so $3 < \sqrt{11} < 4$; between 3 and 4
 73. $\sqrt{64} < \sqrt{80} < \sqrt{81}$, so $8 < \sqrt{80} < 9$; between 8 and 9 74. $-\sqrt{64} < -\sqrt{51} < -\sqrt{49}$, so $-8 < -\sqrt{51} < -7$; between -8 and -7
 75. $\sqrt{121} < \sqrt{125} < \sqrt{144}$, so $11 < \sqrt{125} < 12$; between 11 and 12 76. $-\sqrt{1.44} = -1.2$, rational
 77. $\sqrt{130}$, irrational 78. $\sqrt{\frac{2}{3}}$, irrational 79. $\sqrt{\frac{1}{36}} = \frac{1}{6}$, rational 80. $x(8x - 4) = x(8x) - x(4) = 8x^2 - 4x$
 81. $(4a + 5)3a = 4a(3a) + 5(3a) = 12a^2 + 15a$
 82. $6t^2(3t - 1) = 6t^2(3t) - 6t^2(1) = 18t^3 - 6t^2$
 83. $2p^3(13 - 5p) = 2p^3(13) - 2p^3(5p) = 26p^3 - 10p^4 = -10p^4 + 26p^3$ 84. $5b(3b^2 + b - 9) = 5b(3b^2) + 5b(b) - 5b(9) = 15b^3 + 5b^2 - 45b$
 85. $-7v(v^3 - 6v + 1) = -7v(v^3) - 7v(-6v) - 7v(1) = -7v^4 + 42v^2 - 7v$

11-3 The Distance and Midpoint Formulas pages 591–597

Check Skills You'll Need For complete solutions see Daily Skills Check and Lesson Quiz Transparencies or Presentation Pro CD-ROM.

1. 5 2. 5.4 3. 8.5 4. 8.6 5. 10 6. 2 7. -6 8. -6.5

Check Understanding

1. $d = \sqrt{(-5 - (-7))^2 + (4 - 0)^2} = \sqrt{2^2 + 4^2} = \sqrt{4 + 16} = \sqrt{20} \approx 4.5$; about 4.5 units 2a. $ST = \sqrt{(1 - (-8))^2 + (-2 - 1)^2} = \sqrt{9^2 + (-3)^2} = \sqrt{81 + 9} = \sqrt{90}$; $RT = \sqrt{(3 - 1)^2 + (4 - (-2))^2} = \sqrt{2^2 + 6^2} = \sqrt{4 + 36} = \sqrt{40}$; $RS = \sqrt{3 - (-8))^2 + (4 - 1)^2} = \sqrt{11^2 + 3^2} = \sqrt{121 + 9} = \sqrt{130}$; Perimeter = $\sqrt{90} + \sqrt{40} + \sqrt{130} \approx 27.2$ units
 2b. $(RS)^2 = (RT)^2 + (ST)^2$, or $(\sqrt{130})^2 = (\sqrt{40})^2 + (\sqrt{90})^2$ 3. midpoint = $\left(\frac{-3 + 5}{2}, \frac{-1 + 2}{2}\right) = \left(\frac{2}{2}, \frac{1}{2}\right) = \left(1, \frac{1}{2}\right)$ 4. center = $\left(\frac{-4 + (-8)}{2}, \frac{7 + (-2)}{2}\right) = \left(\frac{-12}{2}, \frac{5}{2}\right) = (-6, 2\frac{1}{2})$

Exercises 1. horizontal line segment: $d = 7 - (-8) = 15$

2. vertical line segment: $d = 7 - (-7) = 14$

3. $d = \sqrt{(6 - 0)^2 + (-8 - 0)^2} = \sqrt{6^2 + (-8)^2} = \sqrt{36 + 64} = \sqrt{100} = 10$

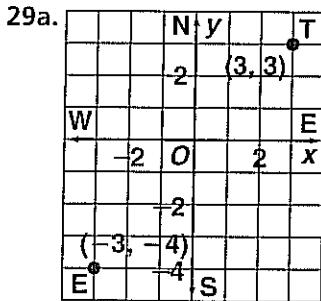
4. $d = \sqrt{(4 - (-4))^2 + (4 - (-4))^2} = \sqrt{8^2 + 8^2} = \sqrt{64 + 64} = \sqrt{128} \approx 11.3$

5. $d = \sqrt{(11 - 9)^2 + (12 - 10)^2} = \sqrt{2^2 + 2^2} = \sqrt{4 + 4} = \sqrt{8} \approx 2.8$

6. $d = \sqrt{(-1 - 3)^2 + (5 - (-2))^2} = \sqrt{(-4)^2 + 7^2} =$

- $\sqrt{16 + 49} = \sqrt{65} \approx 8.1$ 7. $AC = 6$; $AB = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$; $BC = AB = 5$; Perimeter = $6 + 5 + 5 = 16$ 8. $AD = 5$; $BC = 8$; $AB = \sqrt{2^2 + 4^2} = \sqrt{4 + 16} = \sqrt{20}$; $DC = \sqrt{1^2 + 4^2} = \sqrt{1 + 16} = \sqrt{17}$; Perimeter = $5 + 8 + \sqrt{20} + \sqrt{17} \approx 21.6$
 9. midpoint = $\left(\frac{2 + 0}{2}, \frac{5 + 7}{2}\right) = \left(\frac{2}{2}, \frac{12}{2}\right) = (1, 6)$
 10. midpoint = $\left(\frac{-3 + 1}{2}, \frac{14 + 10}{2}\right) = \left(\frac{-2}{2}, \frac{24}{2}\right) = (-1, 12)$
 11. midpoint = $\left(\frac{4 + (-4)}{2}, \frac{1 + (-1)}{2}\right) = \left(\frac{0}{2}, \frac{0}{2}\right) = (0, 0)$
 12. midpoint = $\left(\frac{5 + (-9)}{2}, \frac{3 + 3}{2}\right) = \left(\frac{-4}{2}, \frac{6}{2}\right) = (-2, 3)$
 13. midpoint = $\left(\frac{12 + (-2)}{2}, \frac{-2 + (-9)}{2}\right) = \left(\frac{10}{2}, \frac{-11}{2}\right) = \left(5, -5\frac{1}{2}\right)$ 14. midpoint = $\left(\frac{0 + (-5)}{2}, \frac{6 + (-8)}{2}\right) = \left(\frac{-5}{2}, \frac{-2}{2}\right) = \left(-2\frac{1}{2}, -1\right)$ 15. center = $\left(\frac{-1 + (-7)}{2}, \frac{8 + 0}{2}\right) = \left(\frac{-8}{2}, \frac{8}{2}\right) = (-4, 4)$ 16. center = $\left(\frac{5 + 12}{2}, \frac{-11 + (-7)}{2}\right) = \left(\frac{17}{2}, \frac{-18}{2}\right) = \left(8\frac{1}{2}, -9\right)$
 17. A(-4, 5) and B(4, -2); $AB = \sqrt{(4 - (-4))^2 + (-2 - 5)^2} = \sqrt{8^2 + (-7)^2} = \sqrt{64 + 49} = \sqrt{113} \approx 10.6$ 18. A(-4, -3) and B(4, 2); $AB = \sqrt{(4 - (-4))^2 + (2 - (-3))^2} = \sqrt{8^2 + 5^2} = \sqrt{64 + 25} = \sqrt{89} \approx 9.4$ 19. $AB = \sqrt{(6 - 2)^2 + (3 - 2)^2} = \sqrt{4^2 + 1^2} = \sqrt{16 + 1} = \sqrt{17} \approx 4.1$; $BC = \sqrt{(5 - 6)^2 + (6 - 3)^2} = \sqrt{(-1)^2 + 3^2} = \sqrt{1 + 9} = \sqrt{10} \approx 3.2$; $AC = \sqrt{(5 - 2)^2 + (6 - 2)^2} = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$
 20. $DE = \sqrt{(-2 - (-1))^2 + (-1 - (-7))^2} = \sqrt{(-1)^2 + 6^2} = \sqrt{1 + 36} = \sqrt{37} \approx 6.1$; $EF = \sqrt{(-5 - (-2))^2 + (-3 - (-1))^2} = \sqrt{(-3)^2 + (-2)^2} = \sqrt{9 + 4} = \sqrt{13} \approx 3.6$; $DF = \sqrt{(-5 - (-1))^2 + (-3 - (-7))^2} = \sqrt{(-4)^2 + 4^2} = \sqrt{16 + 16} = \sqrt{32} \approx 5.7$
 21. $RS = \sqrt{(1 - (-2))^2 + (1 - 2)^2} = \sqrt{3^2 + (-1)^2} = \sqrt{9 + 1} = \sqrt{10} \approx 3.2$; $ST = \sqrt{(-3 - 1)^2 + (-3 - 1)^2} = \sqrt{(-4)^2 + (-4)^2} = \sqrt{16 + 16} = \sqrt{32} \approx 5.7$; $RT = \sqrt{(-3 - (-2))^2 + (-3 - 2)^2} = \sqrt{(-1)^2 + (-5)^2} = \sqrt{1 + 25} = \sqrt{26} \approx 5.1$
 22. $MN = \sqrt{(4 - (-1))^2 + (-4 - (-5))^2} = \sqrt{5^2 + 1^2} = \sqrt{25 + 1} = \sqrt{26} \approx 5.1$; $NP = \sqrt{(2 - 4)^2 + (-1 - (-4))^2} = \sqrt{(-2)^2 + 3^2} = \sqrt{4 + 9} = \sqrt{13} \approx 3.6$; $MP = \sqrt{(2 - (-1))^2 + (-1 - (-5))^2} = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$ 23. $JK = \sqrt{(3 - 3)^2 + (9 - 5)^2} = \sqrt{0^2 + 4^2} = \sqrt{0 + 16} = \sqrt{16} = 4$; $KL = \sqrt{(5 - 3)^2 + (8 - 9)^2} = \sqrt{2^2 + (-1)^2} = \sqrt{4 + 1} = \sqrt{5} \approx 2.2$; $LJ =$

$\sqrt{(5-3)^2 + (8-5)^2} = \sqrt{2^2 + 3^2} = \sqrt{4+9} =$
 $\sqrt{13} \approx 3.6$ **24.** $TU = \sqrt{(6 - (-1))^2 + (7 - 4)^2} =$
 $\sqrt{7^2 + 3^2} = \sqrt{49 + 9} = \sqrt{58} \approx 7.6$; $UV =$
 $\sqrt{(2 - 6)^2 + (-9 - 7)^2} = \sqrt{(-4)^2 + (-16)^2} =$
 $\sqrt{16 + 256} = \sqrt{272} \approx 16.5$; $TV =$
 $\sqrt{(2 - (-1))^2 + (-9 - 4)^2} = \sqrt{3^2 + (-13)^2} =$
 $\sqrt{9 + 169} = \sqrt{178} \approx 13.3$ **25a.** $O(0,0)$ and $R(2,5)$;
 $OR = \sqrt{(2 - 0)^2 + (5 - 0)^2} = \sqrt{2^2 + 5^2} =$
 $\sqrt{4 + 25} = \sqrt{29}$; $S(8,3)$ and $T(6,-2)$; $ST =$
 $\sqrt{(6 - 8)^2 + (-2 - 3)^2} = \sqrt{(-2)^2 + (-5)^2} =$
 $\sqrt{4 + 25} = \sqrt{29}$ **25b.** slope of OR : $\frac{5-0}{2-0} = \frac{5}{2}$; slope of
 ST : $\frac{-2-3}{6-8} = \frac{-5}{-2} = \frac{5}{2}$ **25c.** yes **26a.** 80R20: (20, 80);
30L40: (-40, 30) **26b.** $d =$
 $\sqrt{(-40 - 20)^2 + (30 - 80)^2} = \sqrt{(-60)^2 + (-50)^2} =$
 $\sqrt{3600 + 2500} = \sqrt{6100} \approx 78.1$; 78.1 ft
26c. midpoint = $\left(\frac{20 + (-40)}{2}, \frac{80 + 30}{2}\right) = \left(\frac{-20}{2}, \frac{110}{2}\right) =$
(-10, 55), or 55L10 **27.** Answers may vary. Sample:
Suppose you have (1, 1) and (4, -3). To find the
distance, square the difference between the
x-coordinates. Square the difference between the
y-coordinates. Find the sum and take the square root, so
 $\sqrt{9 + 16} = 5$. To find the midpoint, add x-coordinates
together and divide by 2. Repeat for y-coordinates. So,
 $\left(\frac{1+4}{2}, \frac{1-3}{2}\right) = \left(\frac{5}{2}, -1\right)$. **28.** Check students' work.



30. $G(-2, -5)$ and $W(1, 4)$;
 $d = \sqrt{(1 - (-2))^2 + (4 - (-5))^2} =$
 $\sqrt{3^2 + 9^2} = \sqrt{9 + 81} = \sqrt{90} \approx 9.5$; about 9.5 km apart

31a. $A(-20, 0)$ and $B(15, -15)$; $AB =$
 $\sqrt{(15 - (-20))^2 + (-15 - 0)^2} = \sqrt{35^2 + (-15)^2} =$
 $\sqrt{1225 + 225} = \sqrt{1450} \approx 38.1$; about 38.1 mi apart

31b. Helicopter A : 20 mi; Helicopter B : $15^2 + 15^2 = x^2$;
 $225 + 225 = x^2$; $450 = x^2$, $\sqrt{450} = \sqrt{x^2}$; $x \approx 21.2$; about 21.2 mi

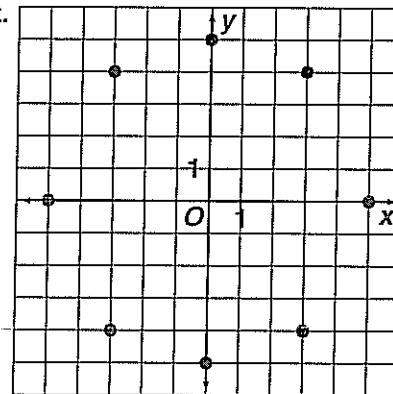
31c. Helicopter A : $20 \text{ mi} \cdot \frac{1 \text{ h}}{80 \text{ mi}} = 0.25 \text{ h} = 15 \text{ min}$;
 Helicopter B : $21.2 \text{ mi} \cdot \frac{1 \text{ h}}{80 \text{ mi}} = 0.265 \text{ h} \approx 16 \text{ min}$

32. $PQ = \sqrt{(2 - 6)^2 + (2 - 5)^2} =$
 $\sqrt{(-4)^2 + (-3)^2} = \sqrt{16 + 9} = \sqrt{25} = 5$;

$QR = \sqrt{(6 - 2)^2 + (-1 - 2)^2} = \sqrt{4^2 + (-3)^2} =$
 $\sqrt{16 + 9} = \sqrt{25} = 5$;

$RS = \sqrt{(10 - 6)^2 + (2 - (-1))^2} = \sqrt{4^2 + 3^2} =$
 $\sqrt{16 + 9} = \sqrt{25} = 5$;

$PS = \sqrt{(10 - 6)^2 + (2 - 5)^2} = \sqrt{4^2 + (-3)^2} = \sqrt{16 + 9} = \sqrt{25} = 5$; yes, $PQRS$ is a rhombus because all sides are congruent. **33a.** midpoint = $\left(\frac{-24 + (-30)}{2}, \frac{-7 + (-3)}{2}\right) = \left(\frac{-54}{2}, \frac{-10}{2}\right) = (-27, -5)$;
 $R(-27, -5)$ **33b.** $PR = \sqrt{(-27 - (-24))^2 + (-5 - (-7))^2} = \sqrt{(-3)^2 + 2^2} = \sqrt{9 + 4} = \sqrt{13} \approx 3.6$;
 $RQ = \sqrt{(-30 - (-27))^2 + (-3 - (-5))^2} = \sqrt{(-3)^2 + 2^2} = \sqrt{9 + 4} = \sqrt{13} \approx 3.6$
34a. $V(-1, -3)$ and $T(2, 5)$; $VT = \sqrt{(2 - (-1))^2 + (5 - (-3))^2} = \sqrt{3^2 + 8^2} = \sqrt{9 + 64} = \sqrt{73}$; $\frac{1}{2}VT = \frac{1}{2}\sqrt{73} \approx 4.3$; about 4.3 mi
34b. $V(-1, -3)$, $T(2, 5)$, and $F(7, -3)$; $VF = 8$;
 $FT = \sqrt{(7 - 2)^2 + (-3 - 5)^2} = \sqrt{5^2 + (-8)^2} = \sqrt{25 + 64} = \sqrt{89} \approx 9.4$; $8 + 9.4 = 17.4$; about 17.4 mi
35a. $A(-2, 1)$ and $B(1, 5)$, midpoint = $\left(\frac{-2 + 1}{2}, \frac{1 + 5}{2}\right) = \left(\frac{-1}{2}, \frac{6}{2}\right) = (-0.5, 3)$, $M(-0.5, 3)$; $C(5, 5)$ and $D(6, 1)$, midpoint = $\left(\frac{5 + 6}{2}, \frac{5 + 1}{2}\right) = \left(\frac{11}{2}, \frac{6}{2}\right) = (5.5, 3)$, $N(5.5, 3)$
35b. $BC = 4$, $AD = 8$, average = $(4 + 8) \div 2 = 6$;
 $MN = 5.5 - (-0.5) = 6$; they are equal. **36.** center = $\left(\frac{x - 3 + x + 3}{2}, \frac{y + 2 + y - 2}{2}\right) = \left(\frac{2x}{2}, \frac{2y}{2}\right) = (x, y)$
37. They are opposites.



39a. line n has slope $-\frac{4}{3}$ and goes through point $(0, 1)$;
 $y - 1 = -\frac{4}{3}(x - 0)$; $y - 1 = -\frac{4}{3}x$; $y = -\frac{4}{3}x + 1$

39b. use substitution: $-\frac{4}{3}x + 1 = \frac{3}{4}x - \frac{11}{4}$; $-\frac{25}{12}x = -\frac{15}{4}$;
 $x = \left(-\frac{15}{4}\right)\left(-\frac{12}{25}\right) = \frac{9}{5}$; $y = -\frac{4}{3}\left(\frac{9}{5}\right) + 1 = -\frac{36}{15} + \frac{15}{15} = -\frac{21}{15} = -\frac{7}{5}$ $\left(\frac{9}{5}, -\frac{7}{5}\right)$ **39c.** $B(0, 1)$ and $C\left(\frac{9}{5}, -\frac{7}{5}\right)$;
 $BC = \sqrt{\left(\frac{9}{5} - 0\right)^2 + \left(-\frac{7}{5} - 1\right)^2} = \sqrt{\left(\frac{9}{5}\right)^2 + \left(-\frac{12}{5}\right)^2} = \sqrt{\frac{81}{25} + \frac{144}{25}} = \sqrt{\frac{225}{25}} = \sqrt{9} = 3$ **40.** distance from
 $(-6, 0)$ to $(-2, 3)$: $d = \sqrt{(-2 - (-6))^2 + (3 - 0)^2} = \sqrt{4^2 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = 5$; distance from

(1, -1) to (-2, 3): $d = \sqrt{(-2 - 1)^2 + (3 - (-1))^2} = \sqrt{(-3)^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$; distance from (-5, 7) to (-2, 3): $d = \sqrt{(-2 - (-5))^2 + (3 - 7)^2} = \sqrt{3^2 + (-4)^2} = \sqrt{9 + 16} = \sqrt{25} = 5$; yes, (-2, 3) is the center because the distance from each point to the center is 5.

41. $d = \sqrt{(8 - (-5))^2 + (-4 - 10)^2} = \sqrt{13^2 + (-14)^2} = \sqrt{169 + 196} = \sqrt{365} \approx 19.1$

42. $\frac{12 + (-2)}{2} = \frac{10}{2} = 5$ **43.** distance from (4.5, 0.5) to (-1.5, -2.5): $d = \sqrt{(-1.5 - 4.5)^2 + (-2.5 - 0.5)^2} = \sqrt{(-6)^2 + (-3)^2} = \sqrt{36 + 9} = \sqrt{45}$; distance from (-1.5, -2.5) to (-4.5, 3.5):
 $d = \sqrt{(-4.5 - (-1.5))^2 + (3.5 - (-2.5))^2} = \sqrt{(-3)^2 + 6^2} = \sqrt{9 + 36} = \sqrt{45}$; distance from (4.5, 0.5) to (-4.5, 3.5): $d = \sqrt{(-4.5 - 4.5)^2 + (3.5 - 0.5)^2} = \sqrt{(-9)^2 + 3^2} = \sqrt{81 + 9} = \sqrt{90}$; perimeter = $\sqrt{45} + \sqrt{45} + \sqrt{90} \approx 22.9$

44. $\frac{-1 + (-9)}{2} = \frac{-10}{2} = -5$

45. $\sqrt{(x - 3)^2 + (4 - (-1))^2} = 5$;
 $\sqrt{(x - 3)^2 + 5^2} = 5$; $\sqrt{5^2} = 5$, so $(x - 3)^2 = 0$, and $x = 3$

46. $\frac{y + 16}{2} = 4$; $y + 16 = 8$; $y = -8$ **47.** (-4, 3) and (6, -3); $d = \sqrt{(6 - (-4))^2 + (-3 - 3)^2} = \sqrt{10^2 + (-6)^2} = \sqrt{100 + 36} = \sqrt{136} = 11.7$

48. $a^2 + b^2 = c^2$; $2^2 + 11^2 = c^2$; $4 + 121 = c^2$; $125 = c^2$;
 $\sqrt{125} = \sqrt{c^2}$; $c \approx 11.2$ **49.** $a^2 + b^2 = c^2$; $8^2 + b^2 = 13^2$;
 $64 + b^2 = 169$; $b^2 = 105$; $\sqrt{b^2} = \sqrt{105}$; $b \approx 10.2$

50. $a^2 + b^2 = c^2$; $10^2 + 24^2 = c^2$; $100 + 576 = c^2$; $676 = c^2$; $\sqrt{676} = \sqrt{c^2}$; $c = 26$ **51.** $a^2 + b^2 = c^2$; $(\sqrt{15})^2 + b^2 = (\sqrt{27})^2$; $15 + b^2 = 27$; $b^2 = 12$; $\sqrt{b^2} = \sqrt{12}$; $b \approx 3.5$

52. $a^2 + b^2 = c^2$; $5^2 + b^2 = (\sqrt{89})^2$; $25 + b^2 = 89$; $b^2 = 64$; $\sqrt{b^2} = \sqrt{64}$; $b = 8$ **53.** $a^2 + b^2 = c^2$; $0.9^2 + 4^2 = c^2$;
 $0.81 + 16 = c^2$; $16.81 = c^2$; $\sqrt{16.81} = \sqrt{c^2}$; $c = 4.1$

54. $t^2 - 196 = 0$; $t^2 = 196$; $t = \pm\sqrt{196}$; $t = \pm 14$ **55.** $3k^2 = 300$; $k^2 = 100$; $k = \pm\sqrt{100}$; $k = \pm 10$ **56.** $5y^2 + 1 = 0$;
 $5y^2 = -1$; $y^2 = -\frac{1}{5}$; no solution **57.** $8m^2 - 9 = 191$; $8m^2 = 200$; $m^2 = 25$; $m = \pm\sqrt{25}$; $m = \pm 5$ **58.** $16q^2 + 9 = 4$;
 $16q^2 = -5$; $q^2 = -\frac{5}{16}$; no solution **59.** $9b^2 + 1 = 5$; $9b^2 = 4$; $b^2 = \frac{4}{9}$; $b = \pm\sqrt{\frac{4}{9}}$; $b = \pm\frac{2}{3}$ **60.** $(k + 3)(k + 8) = k^2 + 8k + 3k + 24 = k^2 + 11k + 24$ **61.** $(v - 5)(v + 7) = v^2 + 7v - 5v - 35 = v^2 + 2v - 35$ **62.** $(2p + 1)(p - 9) = 2p^2 - 18p + 1p - 9 = 2p^2 - 17p - 9$

63. $(8w^2 + 11)(w^2 + 1) = 8w^4 + 8w^2 + 11w^2 + 11 = 8w^4 + 19w^2 + 11$ **64.** $(7t - 2)(t^2 + t + 1) = 7t^3 + 7t^2 + 7t - 2t^2 - 2t - 2 = 7t^3 + 5t^2 + 5t - 2$

65. $(6c + 3)(c^2 - 5c + 8) = 6c^3 - 30c^2 + 48c + 3c^2 - 15c + 24 = 6c^3 - 27c^2 + 33c + 24$

CHECKPOINT QUIZ 1

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- $\sqrt{8} \cdot \sqrt{20} = \sqrt{8 \cdot 20} = \sqrt{160} = \sqrt{16 \cdot 10} = \sqrt{16} \cdot \sqrt{10} = 4\sqrt{10}$
- $\sqrt{45} \cdot \sqrt{3} = \sqrt{45 \cdot 3} = \sqrt{135} = \sqrt{9 \cdot 15} = \sqrt{9} \cdot \sqrt{15} = 3\sqrt{15}$
- $\sqrt{\frac{12}{27}} = \sqrt{\frac{4}{9}} = \frac{\sqrt{4}}{\sqrt{9}} = \frac{2}{3}$
- $\frac{5}{\sqrt{2x^3}} = \frac{5}{\sqrt{2x^3}} \cdot \frac{\sqrt{2x}}{\sqrt{2x}} = \frac{5\sqrt{2x}}{\sqrt{4x^4}} = \frac{5\sqrt{2x}}{2x^2}$
- $x^2 + 13^2 = 15^2$; $x^2 + 169 = 225$; $x^2 = 56$; $\sqrt{x^2} = \sqrt{56}$; $x \approx 7.5$; 7.5 cm
- $x^2 + 19^2 = 24.3^2$; $x^2 + 361 = 590.49$; $x^2 = 229.49$; $\sqrt{x^2} = \sqrt{229.49}$; $x \approx 15.1$; 15.1 in.
- $5^2 + 7^2 = x^2$; $25 + 49 = x^2$; $74 = x^2$; $\sqrt{74} = \sqrt{x^2}$; $x \approx 8.6$; 8.6 ft
- $9^2 + 12^2 = 15^2$; $81 + 144 = 225$; 225 = 225; yes
- $2^2 + 4^2 = 5^2$; $4 + 16 = 25$; $20 \neq 25$; no
- 10a.** midpoint = $\left(\frac{-4 + 4}{2}, \frac{-2 + 3}{2}\right) = \left(\frac{0}{2}, \frac{1}{2}\right) = \left(0, \frac{1}{2}\right)$
- 10b.** $d = \sqrt{(4 - (-4))^2 + (3 - (-2))^2} = \sqrt{8^2 + 5^2} = \sqrt{64 + 25} = \sqrt{89} \approx 9.4$

EXTENSION

pages 598–599

- $x = 5 \cdot \sqrt{2} \approx 7.1$; 7.1 cm
- $h = 12 \cdot \sqrt{2} \approx 17.0$; 17.0 in.
- $y = 7 \cdot \sqrt{2} \approx 9.9$; 9.9 ft
- $d = 90 \cdot \sqrt{2} \approx 127.3$; 127.3 ft
- $40.2 \div \sqrt{2} \approx 28.4$; 28.4 ft
- Answers may vary. Sample: legs of length $\sqrt{2}$ and hypotenuse of length 2
- $x = \sqrt{3} \cdot 4 \approx 6.9$, longer leg is about 6.9 cm;
- $y = 2 \cdot 4 = 8$, hypotenuse is 8 cm
- $w = \sqrt{3} \cdot 6 \approx 10.4$, longer leg is about 10.4 ft
- $h = 2 \cdot 6 = 12$, hypotenuse is 12 ft
- $x = \sqrt{3} \cdot 3 \approx 5.2$, longer leg is about 5.2 m;
- $y = 2 \cdot 3 = 6$, hypotenuse is 6 m

11-4 Operations With Radical Expressions

pages 600–606

Check Skills You'll Need For complete solutions see Daily Skills Check and Lesson Quiz Transparencies or Presentation Pro CD-ROM.

- $2\sqrt{13}$
- $10\sqrt{2}$
- $12\sqrt{6}$
- $5x\sqrt{5}$
- $\frac{\sqrt{33}}{11}$
- $\frac{\sqrt{10}}{4}$
- $\frac{\sqrt{30x}}{2x}$

Check Understanding

- $-3\sqrt{5} - 4\sqrt{5} = (-3 - 4)\sqrt{5} = -7\sqrt{5}$
- $\sqrt{10} - 5\sqrt{10} = 1\sqrt{10} - 5\sqrt{10} = (1 - 5)\sqrt{10} = -4\sqrt{10}$
- $3\sqrt{20} + 2\sqrt{5} = 3\sqrt{4 \cdot 5} + 2\sqrt{5} = 3\sqrt{4} \cdot \sqrt{5} + 2\sqrt{5} = 3(2)\sqrt{5} + 2\sqrt{5} = 6\sqrt{5} + 2\sqrt{5} = (6 + 2)\sqrt{5} = 8\sqrt{5}$
- $3\sqrt{3} - 2\sqrt{9 \cdot 3} = 3\sqrt{3} - 2\sqrt{9} \cdot \sqrt{3} = 3\sqrt{3} - 2(3)\sqrt{3} = 3\sqrt{3} - 6\sqrt{3} = (3 - 6)\sqrt{3} = -3\sqrt{3}$
- $\sqrt{5}(2 + \sqrt{10}) = 2\sqrt{5} + \sqrt{50} = 2\sqrt{5} + \sqrt{25 \cdot 2} = 2\sqrt{5} + 5\sqrt{2}$
- $\sqrt{2x}(\sqrt{6x} - 11) = \sqrt{12x^2} - 11\sqrt{2x} = \sqrt{4x^2} \cdot \sqrt{3} - 11\sqrt{2x} = 2x\sqrt{3} - 11\sqrt{2x}$

11.5 Solving Radical Equations

pages 607–612

Check Skills You'll Need For complete solutions see Daily Skills Check and Lesson Quiz Transparencies or Presentation Pro CD-ROM.

1. 1 2. 4 3. 4 4. 3 5. $x + 1 = 6$. $2x - 5$

Check Understanding 1a. $\sqrt{x+7} = 12$; $\sqrt{x} = 5$; $(\sqrt{x})^2 = 5^2$; $x = 25$; Check: $\sqrt{25+7} \stackrel{?}{=} 12$; $5+7 = 12$ 1b. $\sqrt{a-4} = 5$; $\sqrt{a} = 9$; $(\sqrt{a})^2 = 9^2$; $a = 81$; Check: $\sqrt{81-4} \stackrel{?}{=} 5$; $9-4 = 5$ 1c. $\sqrt{c-2} = 6$; $(\sqrt{c-2})^2 = 6^2$; $c-2 = 36$; $c = 38$; Check: $\sqrt{38-2} \stackrel{?}{=} 6$; $\sqrt{36} \stackrel{?}{=} 6$; $6 = 6$ 2a. $V = 8\sqrt{h-2r}$; $35 = 8\sqrt{h-2(24)}$; $\frac{35}{8} = \sqrt{h-48}$; $(\frac{35}{8})^2 = (\sqrt{h-48})^2$; $\frac{1225}{64} = h-48$; $h = \frac{1225}{64} + 48 \approx 67$; about 67 ft 2b. No; $h-2r$ decreases as r increases.

3. $\sqrt{3t+4} = \sqrt{5t-6}$; $(\sqrt{3t+4})^2 = (\sqrt{5t-6})^2$; $3t+4 = 5t-6$; $10 = 2t$; $t = 5$; Check: $\sqrt{3(5)+4} \stackrel{?}{=} \sqrt{5(5)-6}$; $\sqrt{19} = \sqrt{19}$ 4a. A principal square root must be a nonnegative number. 4b. $y = \sqrt{y+2}$; $y^2 = (\sqrt{y+2})^2$; $y^2 = y+2$; $y^2 - y - 2 = 0$; $(y-2)(y+1) = 0$; $y-2 = 0$ or $y+1 = 0$; $y = 2$ or $y = -1$; Check $y = 2$: $2 \stackrel{?}{=} \sqrt{2+2}$; $2 \stackrel{?}{=} \sqrt{4}$; $2 = 2$; Check $y = -1$: $-1 \stackrel{?}{=} \sqrt{-1+2}$; $-1 \stackrel{?}{=} \sqrt{1}$; $-1 \neq 1$; the only solution is 2. 5. $8 - \sqrt{2n} = 20$; $-12 = \sqrt{2n}$; a principal square root cannot be negative, so there is no solution.

Exercises 1. $\sqrt{x+3} = 5$; $\sqrt{x} = 2$; $(\sqrt{x})^2 = 2^2$; $x = 4$; Check: $\sqrt{4+3} \stackrel{?}{=} 5$; $2+3 = 5$; the solution is 4. 2. $\sqrt{t+2} = 9$; $\sqrt{t} = 7$; $(\sqrt{t})^2 = 7^2$; $t = 49$; Check: $\sqrt{49+2} \stackrel{?}{=} 9$; $7+2 = 9$; the solution is 49. 3. $\sqrt{s-1} = 5$; $\sqrt{s} = 6$; $(\sqrt{s})^2 = 6^2$; $s = 36$; Check: $\sqrt{36-1} \stackrel{?}{=} 5$; $6-1 = 5$; the solution is 36. 4. $\sqrt{n+7} = 12$; $(\sqrt{n+7})^2 = 12^2$; $n+7 = 144$; $n = 137$; Check: $\sqrt{137+7} \stackrel{?}{=} 12$; $\sqrt{144} \stackrel{?}{=} 12$; $12 = 12$; the solution is 137. 5. $\sqrt{a-6} = 3$; $(\sqrt{a-6})^2 = 3^2$; $a-6 = 9$; $a = 15$; Check: $\sqrt{15-6} \stackrel{?}{=} 3$; $\sqrt{9} \stackrel{?}{=} 3$; $3 = 3$; the solution is 15. 6. $\sqrt{z-7} = -3$; $\sqrt{z} = 4$; $(\sqrt{z})^2 = 4^2$; $z = 16$; Check: $\sqrt{16-7} \stackrel{?}{=} -3$; $4-7 = -3$; the solution is 16. 7. $t = \sqrt{\frac{d}{16}}$; $6 = \sqrt{\frac{d}{16}}$; $6^2 = (\sqrt{\frac{d}{16}})^2$; $36 = \frac{d}{16}$; $d = 576$; 576 ft 8. $I = \sqrt{\frac{P}{R}}$; $8 = \sqrt{\frac{P}{9.4}}$; $8^2 = (\sqrt{\frac{P}{9.4}})^2$; $64 = \frac{P}{9.4}$; $P = 601.6$; 602 watts 9. $\sqrt{3x+1} = \sqrt{5x-8}$; $(\sqrt{3x+1})^2 = (\sqrt{5x-8})^2$; $3x+1 = 5x-8$; $9 = 2x$; $x = 4.5$; Check: $\sqrt{3(4.5)+1} \stackrel{?}{=} \sqrt{5(4.5)-8}$; $\sqrt{14.5} = \sqrt{14.5}$; the solution is 4.5.

10. $\sqrt{2y} = \sqrt{9-y}$; $(\sqrt{2y})^2 = (\sqrt{9-y})^2$; $2y =$

$9-y$; $3y = 9$; $y = 3$; Check: $\sqrt{2(3)} \stackrel{?}{=} \sqrt{9-3}$;

$\sqrt{6} = \sqrt{6}$; the solution is 3. 11. $\sqrt{7v-4} =$

$\sqrt{5v+10}$; $(\sqrt{7v-4})^2 = (\sqrt{5v+10})^2$; $7v-4 =$

$5v+10$; $2v = 14$; $v = 7$; Check: $\sqrt{7(7)-4} \stackrel{?}{=}$

$\sqrt{5(7)+10}$; $\sqrt{45} = \sqrt{45}$; the solution is 7.

12. $\sqrt{s+10} = \sqrt{6-s}$; $(\sqrt{s+10})^2 = (\sqrt{6-s})^2$;

$s+10 = 6-s$; $2s = -4$; $s = -2$; Check: $\sqrt{-2+10} \stackrel{?}{=}$

$\sqrt{6-(-2)}$; $\sqrt{8} = \sqrt{8}$; the solution is -2.

13. $\sqrt{n+5} = \sqrt{5n-11}$; $(\sqrt{n+5})^2 = (\sqrt{5n-11})^2$;

$n+5 = 5n-11$; $-4n = -16$; $n = 4$; Check: $\sqrt{4+5} \stackrel{?}{=}$

$\sqrt{5(4)-11}$; $\sqrt{9} = \sqrt{9}$; the solution is 4.

14. $\sqrt{3m+1} = \sqrt{7m-9}$; $(\sqrt{3m+1})^2 =$

$(\sqrt{7m-9})^2$; $3m+1 = 7m-9$; $-4m = -10$; $m = 2.5$;

Check: $\sqrt{3(2.5)+1} \stackrel{?}{=} \sqrt{7(2.5)-9}$; $\sqrt{8.5} = \sqrt{8.5}$;

the solution is 2.5. 15. $-z = \sqrt{-z+6}$; Check $z = -3$;

$-(-3) \stackrel{?}{=} \sqrt{-(-3)+6}$; $3 \stackrel{?}{=} \sqrt{9}$; $3 = 3$; Check $z = 2$:

$-2 \stackrel{?}{=} \sqrt{-2+6}$; $-2 \stackrel{?}{=} \sqrt{4}$; $-2 \neq 2$; the extraneous

solution is 2. 16. $\sqrt{12-n} = n$; Check $n = -4$:

$\sqrt{12-(-4)} \stackrel{?}{=} -4$; $\sqrt{16} \stackrel{?}{=} -4$; $4 \neq -4$; Check $n = 3$:

$\sqrt{12-3} \stackrel{?}{=} 3$; $\sqrt{9} \stackrel{?}{=} 3$; $3 = 3$; the extraneous solution is

-4. 17. $y = \sqrt{2y}$; Check $y = 0$: $0 \stackrel{?}{=} \sqrt{2(0)}$; $0 \stackrel{?}{=} \sqrt{0}$;

$0 = 0$; Check $y = 2$: $2 \stackrel{?}{=} \sqrt{2(2)}$; $2 \stackrel{?}{=} \sqrt{4}$; $2 = 2$; none

18. $2a = \sqrt{4a+3}$; Check $a = \frac{3}{2}$: $2(\frac{3}{2}) \stackrel{?}{=} \sqrt{4(\frac{3}{2})+3}$;

$3 \stackrel{?}{=} \sqrt{9}$; $3 = 3$; Check $a = -\frac{1}{2}$: $2(-\frac{1}{2}) \stackrel{?}{=} \sqrt{4(-\frac{1}{2})+3}$;

$-1 \stackrel{?}{=} \sqrt{1}$; $-1 \neq 1$; the extraneous solution is $-\frac{1}{2}$.

19. $x = \sqrt{28-3x}$; Check $x = 4$: $4 \stackrel{?}{=} \sqrt{28-3(4)}$; $4 \stackrel{?}{=} \sqrt{16}$; $4 = 4$; Check $x = -7$: $-7 \stackrel{?}{=} \sqrt{28-3(-7)}$; $-7 \stackrel{?}{=} \sqrt{49}$; $-7 \neq 7$; the extraneous solution is -7. 20. $-t =$

$\sqrt{-6t-5}$; Check $t = -5$: $-(-5) \stackrel{?}{=} \sqrt{-6(-5)-5}$;

$5 \stackrel{?}{=} \sqrt{25}$; $5 = 5$; Check $t = -1$: $-(-1) \stackrel{?}{=}$

$\sqrt{-6(-1)-5}$; $1 \stackrel{?}{=} \sqrt{1}$; $1 = 1$; none 21. $x = \sqrt{2x+3}$;

$x^2 = (\sqrt{2x+3})^2$; $x^2 = 2x+3$; $x^2 - 2x - 3 = 0$;

$(x-3)(x+1) = 0$; $x-3 = 0$ or $x+1 = 0$; $x = 3$ or $x = -1$; Check $x = 3$: $3 \stackrel{?}{=} \sqrt{2(3)+3}$; $3 \stackrel{?}{=} \sqrt{9}$; $3 = 3$; Check

$x = -1$: $-1 \stackrel{?}{=} \sqrt{2(-1)+3}$; $-1 \stackrel{?}{=} \sqrt{1}$; $-1 \neq 1$; the

solution is 3. 22. $n = \sqrt{4n+5}$; $n^2 = (\sqrt{4n+5})^2$; $n^2 =$

$4n+5$; $n^2 - 4n - 5 = 0$; $(n-5)(n+1) = 0$; $n-5 = 0$

or $n+1 = 0$; $n = 5$ or $n = -1$; Check $n = 5$: $5 \stackrel{?}{=} \sqrt{4(5)+5}$; $5 \stackrel{?}{=} \sqrt{25}$; $5 = 5$; Check $n = -1$: $-1 \stackrel{?}{=}$

$\sqrt{4(-1)+5}$; $-1 \stackrel{?}{=} \sqrt{1}$; $-1 \neq 1$; the solution is 5.

23. $\sqrt{3b} = -3$; a principal square root cannot be

negative, so there is no solution. 24. $2y = \sqrt{5y+6}$;

$(2y)^2 = (\sqrt{5y+6})^2$; $4y^2 = 5y+6$; $4y^2 - 5y - 6 = 0$;

3c. $\sqrt{5a}(\sqrt{5a} + 3) = \sqrt{25a^2} + 3\sqrt{5a} = 5a + 3\sqrt{5a}$

4a. $(2\sqrt{6} + 3\sqrt{3})(\sqrt{6} - 5\sqrt{3}) =$

$2\sqrt{36} - 10\sqrt{18} + 3\sqrt{18} - 15\sqrt{9} =$

$2(6) - 7\sqrt{18} - 15(3) = 12 - 7\sqrt{9} \cdot \sqrt{2} - 45 =$

$12 - 7(3)\sqrt{2} - 45 = -33 - 21\sqrt{2}$

4b. $(\sqrt{7} + 4)^2 = (\sqrt{7} + 4)(\sqrt{7} + 4) = \sqrt{49} +$

$4\sqrt{7} + 4\sqrt{7} + 16 = 7 + 8\sqrt{7} + 16 = 23 + 8\sqrt{7}$

5a. $\frac{4}{\sqrt{7} + \sqrt{5}} = \frac{4}{\sqrt{7} + \sqrt{5}} \cdot \frac{\sqrt{7} - \sqrt{5}}{\sqrt{7} - \sqrt{5}} = \frac{4(\sqrt{7} - \sqrt{5})}{7 - 5} =$

$\frac{4(\sqrt{7} - \sqrt{5})}{2} = 2\sqrt{7} - 2\sqrt{5}$ 5b. $\frac{-4}{\sqrt{10} + \sqrt{8}} =$

$\frac{-4}{\sqrt{10} + \sqrt{8}} \cdot \frac{\sqrt{10} - \sqrt{8}}{\sqrt{10} - \sqrt{8}} = \frac{-4(\sqrt{10} - \sqrt{8})}{10 - 8} =$

$\frac{-4(\sqrt{10} - \sqrt{8})}{2} = -2\sqrt{10} + 2\sqrt{8} = -2(\sqrt{10} - 2\sqrt{2})$

5c. $\frac{-5}{\sqrt{11} - \sqrt{3}} = \frac{-5}{\sqrt{11} - \sqrt{3}} \cdot \frac{\sqrt{11} + \sqrt{3}}{\sqrt{11} + \sqrt{3}} =$

$\frac{-5(\sqrt{11} + \sqrt{3})}{11 - 3} = \frac{-5(\sqrt{11} + \sqrt{3})}{8} = -\frac{5}{8}\sqrt{11} - \frac{5}{8}\sqrt{3}$

6. $\frac{1 + \sqrt{5}}{2} = \frac{\ell}{34}; 2\ell = 34(1 + \sqrt{5}); \ell = 17(1 + \sqrt{5}) \approx 55; \text{about } 55 \text{ in.}$

Exercises 1. $-3\sqrt{6} + 8\sqrt{6} =$

$(-3 + 8)\sqrt{6} = 5\sqrt{6}$ 2. $16\sqrt{10} + 2\sqrt{10} =$

$(16 + 2)\sqrt{10} = 18\sqrt{10}$ 3. $\sqrt{5} - 3\sqrt{5} =$

$1\sqrt{5} - 3\sqrt{5} = (1 - 3)\sqrt{5} = -2\sqrt{5}$

4. $6\sqrt{7} - 4\sqrt{7} = (6 - 4)\sqrt{7} = 2\sqrt{7}$

5. $15\sqrt{2} - \sqrt{2} = 15\sqrt{2} - 1\sqrt{2} = (15 - 1)\sqrt{2} =$

$14\sqrt{2}$ 6. $-5\sqrt{3} - 3\sqrt{3} = (-5 - 3)\sqrt{3} = -8\sqrt{3}$

7. $\sqrt{32} = \sqrt{16 \cdot 2} = \sqrt{16} \cdot \sqrt{2} = 4\sqrt{2}; \text{yes}$

8. $\sqrt{75} = \sqrt{25 \cdot 3} = \sqrt{25} \cdot \sqrt{3} = 5\sqrt{3}; \text{yes}$

9. $\sqrt{50} = \sqrt{25 \cdot 2} = \sqrt{25} \cdot \sqrt{2} = 5\sqrt{2}; \text{no}$

10. $\sqrt{18} + \sqrt{2} = \sqrt{9 \cdot 2} + \sqrt{2} = \sqrt{9} \cdot \sqrt{2} + \sqrt{2} =$

$3\sqrt{2} + 1\sqrt{2} = (3 + 1)\sqrt{2} = 4\sqrt{2}$

11. $2\sqrt{12} - 7\sqrt{3} = 2\sqrt{4 \cdot 3} - 7\sqrt{3} =$

$2\sqrt{4} \cdot \sqrt{3} - 7\sqrt{3} = 2(2)\sqrt{3} - 7\sqrt{3} =$

$4\sqrt{3} - 7\sqrt{3} = (4 - 7)\sqrt{3} = -3\sqrt{3}$

12. $\sqrt{8} + 2\sqrt{2} = \sqrt{4 \cdot 2} + 2\sqrt{2} =$

$\sqrt{4} \cdot \sqrt{2} + 2\sqrt{2} = 2\sqrt{2} + 2\sqrt{2} = (2 + 2)\sqrt{2} =$

$4\sqrt{2}$ 13. $4\sqrt{5} - 2\sqrt{45} = 4\sqrt{5} - 2\sqrt{9 \cdot 5} =$

$4\sqrt{5} - 2\sqrt{9} \cdot \sqrt{5} = 4\sqrt{5} - 2(3)\sqrt{5} =$

$4\sqrt{5} - 6\sqrt{5} = (4 - 6)\sqrt{5} = -2\sqrt{5}$

14. $3\sqrt{7} - \sqrt{28} = 3\sqrt{7} - \sqrt{4 \cdot 7} =$

$3\sqrt{7} - \sqrt{4} \cdot \sqrt{7} = 3\sqrt{7} - 2\sqrt{7} = (3 - 2)\sqrt{7} =$

$1\sqrt{7} = \sqrt{7}$ 15. $-4\sqrt{10} + 6\sqrt{40} =$

$-4\sqrt{10} + 6\sqrt{4 \cdot 10} = -4\sqrt{10} + 6\sqrt{4} \cdot \sqrt{10} =$

$-4\sqrt{10} + 6(2)\sqrt{10} = -4\sqrt{10} + 12\sqrt{10} =$

$(-4 + 12)\sqrt{10} = 8\sqrt{10}$ 16. $\sqrt{2}(\sqrt{8} - 4) =$

$\sqrt{16} - 4\sqrt{2} = 4 - 4\sqrt{2}$ 17. $\sqrt{3}(\sqrt{27} + 1) =$

$\sqrt{81} + \sqrt{3} = 9 + \sqrt{3}$ 18. $2\sqrt{3}(\sqrt{3} - 1) =$

$2\sqrt{9} - 2\sqrt{3} = 2(3) - 2\sqrt{3} =$

$6 - 2\sqrt{3}$ 19. $\sqrt{3}(\sqrt{15} + 2) = \sqrt{45} + 2\sqrt{3} =$

$\sqrt{9 \cdot 5} + 2\sqrt{3} = \sqrt{9} \cdot \sqrt{5} + 2\sqrt{3} = 3\sqrt{5} + 2\sqrt{3}$

20. $\sqrt{2}(3 + 3\sqrt{2}) = 3\sqrt{2} + 3\sqrt{4} = 3\sqrt{2} + 3(2) =$

$3\sqrt{2} + 6$ 21. $\sqrt{6}(\sqrt{6} - 5) = \sqrt{36} - 5\sqrt{6} =$

$6 - 5\sqrt{6}$ 22. $(3\sqrt{2} + \sqrt{3})(\sqrt{2} - 5\sqrt{3}) =$

$3\sqrt{4} - 15\sqrt{6} + \sqrt{6} - 5\sqrt{9} =$

$3(2) + (-15 + 1)\sqrt{6} - 5(3) = 6 - 14\sqrt{6} - 15 =$

$-9 - 14\sqrt{6}$ 23. $(2\sqrt{5} - \sqrt{6})(4\sqrt{5} - 3\sqrt{6}) =$

$8\sqrt{25} - 6\sqrt{30} - 4\sqrt{30} + 3\sqrt{36} =$

$8(5) + (-6 - 4)\sqrt{30} + 3(6) = 40 - 10\sqrt{30} + 18 =$

$58 - 10\sqrt{30}$ 24. $(\sqrt{7} - 2)^2 = (\sqrt{7} - 2)(\sqrt{7} - 2) =$

$\sqrt{49} - 2\sqrt{7} - 2\sqrt{7} + 4 = 7 + (-2 - 2)\sqrt{7} + 4 =$

$11 - 4\sqrt{7}$ 25. $(2\sqrt{10} + \sqrt{3})^2 =$

$(2\sqrt{10} + \sqrt{3})(2\sqrt{10} + \sqrt{3}) = 4\sqrt{100} +$

$2\sqrt{30} + 2\sqrt{30} + \sqrt{9} = 4(10) + (2 + 2)\sqrt{30} + 3 =$

$40 + 4\sqrt{30} + 3 = 43 + 4\sqrt{30}$

26. $(2\sqrt{11} + 5)(\sqrt{11} + 2) =$

$2\sqrt{121} + 4\sqrt{11} + 5\sqrt{11} + 10 =$

$2(11) + (4 + 5)\sqrt{11} + 10 = 22 + 9\sqrt{11} + 10 =$

$32 + 9\sqrt{11}$ 27. $(4 - \sqrt{13})(9 + \sqrt{13}) =$

$36 + 4\sqrt{13} - 9\sqrt{13} - \sqrt{169} =$

$36 + (4 - 9)\sqrt{13} - 13 = 23 - 5\sqrt{13}$

28. $\frac{8}{\sqrt{7} - \sqrt{3}} = \frac{8}{\sqrt{7} - \sqrt{3}} \cdot \frac{\sqrt{7} + \sqrt{3}}{\sqrt{7} + \sqrt{3}} = \frac{8(\sqrt{7} + \sqrt{3})}{7 - 3} =$

$\frac{8(\sqrt{7} + \sqrt{3})}{4} = 2(\sqrt{7} + \sqrt{3}) = 2\sqrt{7} + 2\sqrt{3}$

29. $\frac{-12}{\sqrt{8} - \sqrt{2}} = \frac{-12}{\sqrt{8} - \sqrt{2}} \cdot \frac{\sqrt{8} + \sqrt{2}}{\sqrt{8} + \sqrt{2}} =$

$\frac{-12(\sqrt{8} + \sqrt{2})}{8 - 2} = \frac{-12(\sqrt{8} + \sqrt{2})}{6} = -2(\sqrt{8} + \sqrt{2}) =$

$-2\sqrt{8} - 2\sqrt{2} = -2\sqrt{4} \cdot \sqrt{2} - 2\sqrt{2} =$

$-2(2)\sqrt{2} - 2\sqrt{2} = -4\sqrt{2} - 2\sqrt{2} = (-4 - 2)\sqrt{2} =$

$-6\sqrt{2}$ 30. $\frac{48}{\sqrt{6} - \sqrt{18}} = \frac{48}{\sqrt{6} - \sqrt{18}} \cdot \frac{\sqrt{6} + \sqrt{18}}{\sqrt{6} + \sqrt{18}} =$

$\frac{48(\sqrt{6} + \sqrt{18})}{6 - 18} = \frac{48(\sqrt{6} + \sqrt{18})}{-12} = -4(\sqrt{6} + \sqrt{18}) =$

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

$-4\sqrt{6} - 12\sqrt{2}$

31. $\frac{3}{\sqrt{10} - \sqrt{5}} = \frac{3}{\sqrt{10} - \sqrt{5}} \cdot \frac{\sqrt{10} + \sqrt{5}}{\sqrt{10} + \sqrt{5}} =$

$\frac{3(\sqrt{10} + \sqrt{5})}{10 - 5} = \frac{3\sqrt{10} + 3\sqrt{5}}{5} = \frac{3}{5}\sqrt{10} + \frac{3}{5}\sqrt{5}$

$$\begin{aligned}
32. \frac{-40}{\sqrt{11} - \sqrt{3}} &= \frac{-40}{\sqrt{11} - \sqrt{3}} \cdot \frac{\sqrt{11} + \sqrt{3}}{\sqrt{11} + \sqrt{3}} = \\
\frac{-40(\sqrt{11} + \sqrt{3})}{11 - 3} &= \frac{-40(\sqrt{11} + \sqrt{3})}{8} = -5(\sqrt{11} + \sqrt{3}) = \\
-5\sqrt{11} - 5\sqrt{3} & \\
33. \frac{9}{\sqrt{12} - \sqrt{11}} &= \frac{9}{\sqrt{12} - \sqrt{11}} \cdot \frac{\sqrt{12} + \sqrt{11}}{\sqrt{12} + \sqrt{11}} = \\
\frac{9(\sqrt{12} + \sqrt{11})}{12 - 11} &= 9(\sqrt{12} + \sqrt{11}) = \\
9(\sqrt{4 \cdot 3} + \sqrt{11}) &= 9(2\sqrt{3} + \sqrt{11}) = 18\sqrt{3} + 9\sqrt{11} \\
34. \frac{5\sqrt{2}}{\sqrt{2} - 1} &= \frac{x}{\sqrt{2}}, x(\sqrt{2} - 1) = \sqrt{2}(5\sqrt{2}); \\
x(\sqrt{2} - 1) &= 10; x = \frac{10}{\sqrt{2} - 1} = \frac{10}{\sqrt{2} - 1} \cdot \frac{\sqrt{2} + 1}{\sqrt{2} + 1} = \\
\frac{10(\sqrt{2} + 1)}{2 - 1} &= \frac{10(\sqrt{2} + 1)}{1} = 10\sqrt{2} + 10; 24.1 \\
35. \frac{3}{1 + \sqrt{5}} &= \frac{1 - \sqrt{5}}{x}, 3x = (1 + \sqrt{5})(1 - \sqrt{5}); 3x = \\
1 - \sqrt{25}; x &= \frac{1 - 5}{3} = -\frac{4}{3}; -1.3 \quad 36. \frac{\sqrt{2} - 1}{\sqrt{2} + 1} = \frac{x}{2}, \\
x(\sqrt{2} + 1) &= 2(\sqrt{2} - 1); x = \frac{2(\sqrt{2} - 1)}{\sqrt{2} + 1} = \\
\frac{2(\sqrt{2} - 1)}{\sqrt{2} + 1} \cdot \frac{\sqrt{2} - 1}{\sqrt{2} - 1} &= \frac{2(\sqrt{2} - 1)^2}{2 - 1} = \\
2(\sqrt{2} - 1)(\sqrt{2} - 1) &= 2(2 - 2\sqrt{2} + 1) = \\
2(3 - 2\sqrt{2}) &= 6 - 4\sqrt{2}; 0.3 \quad 37. \frac{1 + \sqrt{5}}{2} = \frac{12}{w}, \\
w(1 + \sqrt{5}) &= 2(12); w(1 + \sqrt{5}) = 24; w = \frac{24}{1 + \sqrt{5}} = \\
\frac{24}{1 + \sqrt{5}} \cdot \frac{1 - \sqrt{5}}{1 - \sqrt{5}} &= \frac{24(1 - \sqrt{5})}{1 - 5} = \frac{24(1 - \sqrt{5})}{-4} = \\
-6(1 - \sqrt{5}) &= -6 + 6\sqrt{5} \approx 7.4; \text{ about 7.4 ft} \\
38. \sqrt{40} + \sqrt{90} &= \sqrt{4 \cdot 10} + \sqrt{9 \cdot 10} = \\
\sqrt{4} \cdot \sqrt{10} + \sqrt{9} \cdot \sqrt{10} &= 2\sqrt{10} + 3\sqrt{10} = \\
(2 + 3)\sqrt{10} &= 5\sqrt{10} \quad 39. 3\sqrt{2}(2 + \sqrt{6}) = \\
6\sqrt{2} + 3\sqrt{12} &= 6\sqrt{2} + 3\sqrt{4 \cdot 3} = \\
6\sqrt{2} + 3\sqrt{4} \cdot \sqrt{3} &= 6\sqrt{2} + 3(2)\sqrt{3} = \\
6\sqrt{2} + 6\sqrt{3} \quad 40. \sqrt{12} + 4\sqrt{75} - \sqrt{36} &= \\
\sqrt{4 \cdot 3} + 4\sqrt{25 \cdot 3} - 6 &= \\
\sqrt{4} \cdot \sqrt{3} + 4\sqrt{25} \cdot \sqrt{3} - 6 &= \\
2\sqrt{3} + 4(5)\sqrt{3} - 6 &= 2\sqrt{3} + 20\sqrt{3} - 6 = \\
(2 + 20)\sqrt{3} - 6 &= 22\sqrt{3} - 6 \quad 41. (\sqrt{3} + \sqrt{5})^2 = \\
(\sqrt{3} + \sqrt{5})(\sqrt{3} + \sqrt{5}) &= \sqrt{9} + 2\sqrt{15} + \sqrt{25} = \\
3 + 2\sqrt{15} + 5 &= 8 + 2\sqrt{15} \quad 42. \frac{\sqrt{13} + \sqrt{10}}{\sqrt{13} - \sqrt{5}} = \\
\frac{\sqrt{13} + \sqrt{10}}{\sqrt{13} - \sqrt{5}} \cdot \frac{\sqrt{13} + \sqrt{5}}{\sqrt{13} + \sqrt{5}} &= \frac{\sqrt{169} + \sqrt{65} + \sqrt{130} + \sqrt{50}}{13 - 5} = \\
\frac{13 + \sqrt{65} + \sqrt{130} + \sqrt{25 \cdot 2}}{8} &= \frac{13 + \sqrt{65} + \sqrt{130} + 5\sqrt{2}}{8} \\
43. (\sqrt{7} + \sqrt{8})(\sqrt{7} + \sqrt{8}) &= \\
\sqrt{49} + 2\sqrt{56} + \sqrt{64} &= 7 + 2\sqrt{4 \cdot 14} + 8 = \\
7 + 2(2)\sqrt{14} + 8 &= 15 + 4\sqrt{14}
\end{aligned}$$

$$\begin{aligned}
44. 2\sqrt{2}(-2\sqrt{32} + \sqrt{8}) &= -4\sqrt{64} + 2\sqrt{16} = \\
-4(8) + 2(4) &= -32 + 8 = -24 \\
45. 4\sqrt{50} - 7\sqrt{18} &= 4\sqrt{25 \cdot 2} - 7\sqrt{9 \cdot 2} = \\
4\sqrt{25} \cdot \sqrt{2} - 7\sqrt{9} \cdot \sqrt{2} &= 4(5)\sqrt{2} - 7(3)\sqrt{2} = \\
20\sqrt{2} - 21\sqrt{2} &= (20 - 21)\sqrt{2} = -\sqrt{2} \\
46. \frac{2\sqrt{12} + 3\sqrt{6}}{\sqrt{9} - \sqrt{6}} &= \frac{2\sqrt{12} + 3\sqrt{6}}{\sqrt{9} - \sqrt{6}} \cdot \frac{\sqrt{9} + \sqrt{6}}{\sqrt{9} + \sqrt{6}} = \\
\frac{2\sqrt{108} + 2\sqrt{72} + 3\sqrt{54} + 3\sqrt{36}}{9 - 6} &= \\
\frac{2\sqrt{36 \cdot 3} + 2\sqrt{36 \cdot 2} + 3\sqrt{9 \cdot 6} + 3(6)}{3} &= \\
\frac{2\sqrt{36} \cdot \sqrt{3} + 2\sqrt{36} \cdot \sqrt{2} + 3\sqrt{9} \cdot \sqrt{6} + 18}{3} &= \\
\frac{2(6)\sqrt{3} + 2(6)\sqrt{2} + 3(3)\sqrt{6} + 18}{3} &= \\
\frac{12\sqrt{3} + 12\sqrt{2} + 9\sqrt{6} + 18}{3} &= 4\sqrt{3} + 4\sqrt{2} + 3\sqrt{6} + 6 \\
47. \frac{r_1}{r_2} &= \frac{\sqrt{m_1}}{\sqrt{m_2}} = \frac{\sqrt{12}}{\sqrt{30}} = \sqrt{\frac{12}{5}} = \frac{\sqrt{2}}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{\sqrt{10}}{5} \\
48. \text{length of each side is } 2\sqrt{2}; \text{perimeter} &= 4(2\sqrt{2}) = 8\sqrt{2} \text{ units} \quad 49. \text{distance from } (-2, 0) \text{ to } (3, 5): \\
d &= \sqrt{(3 - (-2))^2 + (5 - 0)^2} = \sqrt{5^2 + 5^2} = \\
\sqrt{25 + 25} &= \sqrt{50} = \sqrt{25 \cdot 2} = \sqrt{25} \cdot \sqrt{2} = 5\sqrt{2}; \text{distance from } \\
(-2, 0) \text{ to } (3, -5): 5\sqrt{2}; \text{distance from } \\
(3, -5) \text{ to } (3, 5): 10; \text{perimeter} &= 5\sqrt{2} + 5\sqrt{2} + 10 = \\
(5 + 5)\sqrt{2} + 10 &= (10 + 10\sqrt{2}) \text{ units} \quad 50. x = \\
3\sqrt{5} \div \sqrt{2} &= \frac{3\sqrt{5}}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{3\sqrt{10}}{\sqrt{4}} = \frac{3\sqrt{10}}{2}; \text{perimeter} = \\
4\left(\frac{3\sqrt{10}}{2}\right) &= 6\sqrt{10} \text{ units} \quad 51. \text{Let } y \text{ be the unmarked leg} \\
\text{length. } x^2 + y^2 &= (x\sqrt{10})^2; y^2 = 10x^2 - x^2 = 9x^2; \\
y &= \sqrt{9x^2} = 3x; \text{perimeter} = x + 3x + x\sqrt{10} = \\
(4x + x\sqrt{10}) \text{ units} \quad 52. \text{Answers may vary.} \\
\text{Sample: } 8\sqrt{2} + 4\sqrt{3}, 2\sqrt{7} + 9\sqrt{3}, 6\sqrt{5} + 3\sqrt{7} \\
53a. \text{The student simplified } \sqrt{48} \text{ as } 2\sqrt{24} \text{ instead of } \\
2\sqrt{12} \text{ or } 4\sqrt{3}. \quad 53b. \sqrt{24} + \sqrt{48} = \\
\sqrt{4 \cdot 6} + \sqrt{16 \cdot 3} &= \sqrt{4} \cdot \sqrt{6} + \sqrt{16} \cdot \sqrt{3} = \\
2\sqrt{6} + 4\sqrt{3} \quad 54a. 2\sqrt{2} \text{ ft} \approx 2.8 \text{ ft} \quad 54b. s\sqrt{2} \\
55. r &= \sqrt{\frac{A}{p}} - 1 = \sqrt{\frac{595}{500}} - 1 \approx 0.091, \text{ or } 9.1\% \\
56. r &= \sqrt{\frac{A}{p}} - 1 = \sqrt{\frac{700}{550}} - 1 \approx 0.128, \text{ or } 12.8\% \\
57. r &= \sqrt{\frac{A}{p}} - 1 = \sqrt{\frac{800}{600}} - 1 \approx 0.155, \text{ or } 15.5\% \\
58a. \text{If } n = 2, \sqrt{x^n} &= \sqrt{x^2} = x; \text{if } n = 4, \sqrt{x^n} = \\
\sqrt{x^4} = x^2; \text{if } n = 6, \sqrt{x^n} &= \sqrt{x^6} = x^3; \text{if } n = 8, \sqrt{x^n} = \\
\sqrt{x^8} = x^4; \sqrt{x^n} &= x^{\frac{n}{2}} \quad 58b. \text{If } n = 3, \sqrt{x^n} = \sqrt{x^3} = \\
\sqrt{x^2 \cdot x} = x\sqrt{x}; \text{if } n = 5, \sqrt{x^n} &= \sqrt{x^5} = \sqrt{x^4 \cdot x} = \\
x^2\sqrt{x}; \text{if } n = 7, \sqrt{x^n} &= \sqrt{x^7} = \sqrt{x^6 \cdot x} = x^3\sqrt{x}; \text{if } n = 9, \sqrt{x^n} = \sqrt{x^9} = \\
\sqrt{x^8 \cdot x} = x^4\sqrt{x}; \sqrt{x^n} &= x^{\frac{n-1}{2}}\sqrt{x} \\
59. \frac{a\sqrt{b}}{b\sqrt{a}} &= \frac{a\sqrt{b}}{b\sqrt{a}} \cdot \frac{\sqrt{a}}{\sqrt{a}} = \frac{a\sqrt{ab}}{b\sqrt{a^2}} = \frac{a\sqrt{ab}}{ab} = \frac{\sqrt{ab}}{b} \\
60. 2\sqrt{126} \times \frac{4^2}{5} \div \frac{6}{7} \times 3 &\approx 251; \text{about 251 years}
\end{aligned}$$

61. They are unlike radicals.

62a.

a	b	\sqrt{a}	\sqrt{b}	$\sqrt{a} + \sqrt{b}$	$\sqrt{a + b}$
1	0	1	0	1	1
16	1	4	1	5	$\sqrt{17}$
25	9	5	3	8	$\sqrt{34}$
64	36	8	6	14	10
100	81	10	9	19	$\sqrt{181}$

62b. No; the only values it worked for were 0 and 1.

$$63. \sqrt{a+b} \neq \sqrt{a} + \sqrt{b}$$

$$64. \sqrt{18} + \frac{3}{\sqrt{2}} = \sqrt{9 \cdot 2} + \frac{3}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = 3\sqrt{2} + \frac{3\sqrt{2}}{2} = \left(3 + \frac{3}{2}\right)\sqrt{2} = \frac{9}{2}\sqrt{2} = \frac{9\sqrt{2}}{2}$$

$$65. \frac{\sqrt{28}}{3} + \frac{3}{\sqrt{7}} = \frac{\sqrt{4 \cdot 7}}{3} + \frac{3}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}} = \frac{2\sqrt{7}}{3} + \frac{3\sqrt{7}}{7} = \left(\frac{2}{3} + \frac{3}{7}\right)\sqrt{7} = \left(\frac{14}{21} + \frac{9}{21}\right)\sqrt{7} = \frac{23}{21}\sqrt{7} = \frac{23\sqrt{7}}{21}$$

$$66. \sqrt{\frac{3}{5}} + \sqrt{\frac{5}{3}} = \frac{\sqrt{3}}{\sqrt{5}} + \frac{\sqrt{5}}{\sqrt{3}} = \frac{\sqrt{3} \cdot \sqrt{5} + \sqrt{5} \cdot \sqrt{3}}{\sqrt{5} \cdot \sqrt{5}} = \frac{\sqrt{15} + \sqrt{15}}{\sqrt{25}} = \frac{\sqrt{15}}{5} + \frac{\sqrt{15}}{3} = \left(\frac{1}{5} + \frac{1}{3}\right)\sqrt{15} = \left(\frac{3}{15} + \frac{5}{15}\right)\sqrt{15} = \frac{8}{15}\sqrt{15} = \frac{8\sqrt{15}}{15}$$

$$67. \frac{\sqrt{27} + \sqrt{48} - \sqrt{75}}{\sqrt{3}} = \frac{\sqrt{9 \cdot 3} + \sqrt{16 \cdot 3} - \sqrt{25 \cdot 3}}{\sqrt{3}} = \frac{3\sqrt{3} + 4\sqrt{3} - 5\sqrt{3}}{\sqrt{3}} = \frac{(3+4-5)\sqrt{3}}{\sqrt{3}} = 3+4-5=2$$

$$68. \sqrt{288} + \sqrt{50} - \sqrt{98} = \sqrt{144 \cdot 2} + \sqrt{25 \cdot 2} - \sqrt{49 \cdot 2} = 12\sqrt{2} + 5\sqrt{2} - 7\sqrt{2} = (12+5-7)\sqrt{2} = 10\sqrt{2}$$

$$69. (\sqrt{2} + \sqrt{32})(\sqrt{2} + \sqrt{8} + \sqrt{32}) = \sqrt{4} + \sqrt{16} + \sqrt{64} + \sqrt{64} + \sqrt{256} + \sqrt{1024} = 2+4+8+8+16+32 = 70$$

$$70. \frac{\sqrt{5} + \sqrt{10} - \sqrt{15}}{\sqrt{10} - \sqrt{5}} = \frac{\sqrt{5} + \sqrt{10} - \sqrt{15}}{\sqrt{10} - \sqrt{5}} \cdot \frac{\sqrt{10} + \sqrt{5}}{\sqrt{10} + \sqrt{5}} = \frac{\sqrt{50} + \sqrt{25} + \sqrt{100} + \sqrt{50} - \sqrt{150} - \sqrt{75}}{10-5} = \frac{\sqrt{25 \cdot 2} + 5 + 10 + \sqrt{25 \cdot 2} - \sqrt{25 \cdot 6} - \sqrt{25 \cdot 3}}{5} = \frac{5\sqrt{2} + 15 + 5\sqrt{2} - 5\sqrt{6} - 5\sqrt{3}}{5} = \frac{5(2\sqrt{2} + 3 - \sqrt{6} - \sqrt{3})}{5} = 2\sqrt{2} - \sqrt{6} - \sqrt{3} + 3$$

$$71a. h^2 = (\sqrt{10} + \sqrt{2})^2 + (\sqrt{10} - \sqrt{2})^2 = (\sqrt{10} + \sqrt{2})(\sqrt{10} + \sqrt{2}) + (\sqrt{10} - \sqrt{2})(\sqrt{10} - \sqrt{2}) = \sqrt{100} + 2\sqrt{20} + \sqrt{4} + \sqrt{100} - 2\sqrt{20} + \sqrt{4} = 10 + 2 + 10 + 2 = 24; h = \sqrt{24} = \sqrt{4 \cdot 6} = 2\sqrt{6}$$

$$71b. h^2 = (\sqrt{20} + \sqrt{6})^2 + (\sqrt{20} - \sqrt{6})^2 = (\sqrt{20} + \sqrt{6})(\sqrt{20} + \sqrt{6}) + (\sqrt{20} - \sqrt{6})(\sqrt{20} - \sqrt{6}) = \sqrt{400} + 2\sqrt{120} + \sqrt{36} + \sqrt{400} - 2\sqrt{120} + \sqrt{36} = 20 + 6 + 20 + 6 = 52; h = \sqrt{52} = \sqrt{4 \cdot 13} = 2\sqrt{13}$$

$$71c. h^2 = (\sqrt{p} + \sqrt{q})^2 + (\sqrt{p} - \sqrt{q})^2 =$$

$$(\sqrt{p} + \sqrt{q})(\sqrt{p} + \sqrt{q}) + (\sqrt{p} - \sqrt{q})(\sqrt{p} - \sqrt{q}) =$$

$$\sqrt{p^2} + 2\sqrt{pq} + \sqrt{q^2} + \sqrt{p^2} - 2\sqrt{pq} + \sqrt{q^2} = p + q + p + q = 2p + 2q = 2(p + q); h = \sqrt{2(p + q)}$$

$$72. 4\sqrt{75} + \sqrt{27} = 4\sqrt{25 \cdot 3} + \sqrt{9 \cdot 3} =$$

$$4\sqrt{25} \cdot \sqrt{3} + \sqrt{9} \cdot \sqrt{3} = 4(5)\sqrt{3} + 3\sqrt{3} =$$

$$20\sqrt{3} + 3\sqrt{3} = (20+3)\sqrt{3} = 23\sqrt{3}; B$$

$$73. F. \sqrt{8} + \sqrt{18} = \sqrt{4 \cdot 2} + \sqrt{9 \cdot 2} =$$

$$2\sqrt{2} + 3\sqrt{2} = (2+3)\sqrt{2} = 5\sqrt{2} G. \sqrt{98} - \sqrt{8} =$$

$$\sqrt{49 \cdot 2} - \sqrt{4 \cdot 2} = 7\sqrt{2} - 2\sqrt{2} = (7-2)\sqrt{2} =$$

$$5\sqrt{2} H. -\sqrt{32} + \sqrt{162} = -\sqrt{16 \cdot 2} + \sqrt{81 \cdot 2} =$$

$$-4\sqrt{2} + 9\sqrt{2} = (-4+9)\sqrt{2} = 5\sqrt{2}$$

$$I. \sqrt{48} + \sqrt{2} = \sqrt{16 \cdot 3} + \sqrt{2} = 4\sqrt{3} + \sqrt{2} \neq 5\sqrt{2}; I. 74. [2] (3\sqrt{5} - \sqrt{2})(\sqrt{5} + 5\sqrt{2}) =$$

$$3\sqrt{25} + 15\sqrt{10} - \sqrt{10} - 5\sqrt{4} =$$

$$3(5) + 15\sqrt{10} - \sqrt{10} - 5(2) =$$

$$15 + 15\sqrt{10} - \sqrt{10} - 10 = 5 + 14\sqrt{10}$$

[1] correct technique, but with a computational error

75. [4] Multiply the numerator and the denominator by the conjugate of the denominator. Simplify the denominator.

$$\frac{5}{\sqrt{7} + \sqrt{21}} \cdot \frac{\sqrt{7} - \sqrt{21}}{\sqrt{7} - \sqrt{21}}, \frac{5(\sqrt{7} - \sqrt{21})}{7 - 21}; \frac{5(\sqrt{7} - \sqrt{21})}{-14}$$

[3] correct steps, but answer not completely simplified

[2] correct technique, but with a computational error

[1] correct answer, but no work shown

$$76. d = \sqrt{(8-2)^2 + (13-6)^2} = \sqrt{6^2 + 7^2} = \sqrt{36+49} = \sqrt{85} \approx 9.2 \text{ units}$$

$$77. d = \sqrt{(5-(-1))^2 + (10-7)^2} = \sqrt{6^2 + 3^2} = \sqrt{36+9} = \sqrt{45} \approx 6.7 \text{ units}$$

$$78. d = \sqrt{(20-(-6))^2 + (-1-2)^2} =$$

$$\sqrt{26^2 + (-3)^2} = \sqrt{676+9} = \sqrt{685} \approx 26.2 \text{ units}$$

$$79. \text{midpoint} = \left(\frac{4+2}{2}, \frac{-1+11}{2}\right) = \left(\frac{6}{2}, \frac{10}{2}\right) = (3, 5)$$

$$80. \text{midpoint} = \left(\frac{-5+1}{2}, \frac{6+7}{2}\right) = \left(\frac{-4}{2}, \frac{13}{2}\right) = (-2, 6.5)$$

$$81. 5t^2 - 35t = 0; 5t(t-7) = 0; 5t = 0 \text{ or } t-7 = 0; t = 0 \text{ or } t = 7$$

$$82. p^2 - 7p - 18 = 0; (p+2)(p-9) = 0; p+2 = 0 \text{ or } p-9 = 0; p = -2 \text{ or } p = 9$$

$$83. k^2 + 12k + 27 = 0; (k+9)(k+3) = 0; k+9 = 0$$

$$\text{or } k+3 = 0; k = -9 \text{ or } k = -3$$

$$84. y^2 - 2y = 24; y^2 - 2y - 24 = 0; (y+4)(y-6) = 0; y+4 = 0 \text{ or }$$

$$y-6 = 0; y = -4 \text{ or } y = 6$$

$$85. m^2 + 30 = -17m; m^2 + 17m + 30 = 0; (m+15)(m+2) = 0; m+15 = 0$$

$$\text{or } m+2 = 0; m = -15 \text{ or } m = -2$$

$$86. 2a^2 = -7a - 3; 2a^2 + 7a + 3 = 0; (2a+1)(a+3) = 0; 2a+1 = 0 \text{ or }$$

$$a+3 = 0; 2a = -1 \text{ or } -3; a = -\frac{1}{2} \text{ or } a = -3$$

$$87. (b+11)(b+11) = b^2 + 11b + 11b + 121 = b^2 + 22b + 121$$

$$88. (2p+7)(2p+7) = (2p)^2 + 14p + 49 = 4p^2 + 28p + 49$$

$$89. (5g-7)(5g+7) = (5g)^2 - 7^2 = 25g^2 - 49$$

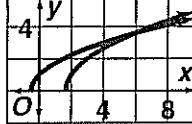
$$90. (3x+1)(3x-1) = (3x)^2 - 1^2 = 9x^2 - 1$$

$$91. \left(\frac{1}{3}k - 9\right)\left(\frac{1}{3}k + 9\right) =$$

$$\left(\frac{1}{3}k\right)^2 - 9^2 = \frac{1}{9}k^2 - 81$$

$$92. (d-1.1)(d+1.1) = d^2 - 1.1d - 1.1d + 1.21 = d^2 - 2.2d + 1.21$$

$(4y + 3)(y - 2) = 0$; $4y + 3 = 0$ or $y - 2 = 0$; $4y = -3$ or $y = 2$; $y = -0.75$ or $y = 2$; Check $y = -0.75$:
 $2(-0.75) \stackrel{?}{=} \sqrt{5(-0.75)} + 6$; $-1.5 \stackrel{?}{=} \sqrt{2.25}$; $-1.5 \neq 1.5$; Check $y = 2$: $2(2) \stackrel{?}{=} \sqrt{5(2) + 6}$; $4 \stackrel{?}{=} \sqrt{16}$; $4 = 4$; the solution is 2. 25. $-2\sqrt{2r + 5} = 6$; $\sqrt{2r + 5} = -3$; a principal square root cannot be negative, so there is no solution. 26. $\sqrt{d + 12} = d$; $(\sqrt{d + 12})^2 = d^2$; $d + 12 = d^2$; $d^2 - d - 12 = 0$; $(d - 4)(d + 3) = 0$; $d - 4 = 0$ or $d + 3 = 0$; $d = 4$ or $d = -3$; Check $d = 4$: $\sqrt{4 + 12} \stackrel{?}{=} 4$; $\sqrt{16} \stackrel{?}{=} 4$; $4 = 4$; Check $d = -3$: $\sqrt{-3 + 12} \stackrel{?}{=} -3$; $\sqrt{9} \stackrel{?}{=} -3$; $3 \neq -3$; the solution is 4. 27. $\sqrt{z + 5} = 2z$; $(\sqrt{z + 5})^2 = (2z)^2$; $z + 5 = 4z^2$; $4z^2 - z - 5 = 0$; $(4z - 5)(z + 1) = 0$; $4z - 5 = 0$ or $z + 1 = 0$; $4z = 5$ or $z = -1$; $z = 1.25$ or $z = -1$; Check $z = 1.25$: $\sqrt{1.25 + 5} \stackrel{?}{=} 2(1.25)$; $\sqrt{6.25} \stackrel{?}{=} 2.5$; $2.5 = 2.5$; Check $z = -1$: $\sqrt{-1 + 5} \stackrel{?}{=} 2(-1)$; $\sqrt{4} \stackrel{?}{=} -2$; $2 \neq -2$; the solution is 1.25, or $\frac{5}{4}$. 28. $2t = \sqrt{5t - 1}$; $(2t)^2 = (\sqrt{5t - 1})^2$; $4t^2 = 5t - 1$; $4t^2 - 5t + 1 = 0$; $(4t - 1)(t - 1) = 0$; $4t - 1 = 0$ or $t - 1 = 0$; $4t = 1$ or $t = 1$; $t = \frac{1}{4}$ or $t = 1$; Check $t = \frac{1}{4}$: $2\left(\frac{1}{4}\right) \stackrel{?}{=} \sqrt{5\left(\frac{1}{4}\right) - 1}$; $\frac{1}{2} \stackrel{?}{=} \sqrt{\frac{1}{4}}$; $\frac{1}{2} = \frac{1}{2}$; Check $t = 1$: $2(1) \stackrel{?}{=} \sqrt{5(1) - 1}$; $2 \stackrel{?}{=} \sqrt{4}$; $2 = 2$; the solutions are $\frac{1}{4}$ and 1. 29a. $CD = \sqrt{AD \cdot DB}$; $10 = \sqrt{AD \cdot 4}$; $10^2 = (\sqrt{AD \cdot 4})^2$; $100 = AD \cdot 4$; $AD = 25$ 29b. $CD = \sqrt{AD \cdot DB}$; $15 = \sqrt{20 \cdot DB}$; $15^2 = (\sqrt{20 \cdot DB})^2$; $225 = 20 \cdot DB$; $DB = 11.25$ 30. $V = \pi r^2 h$; $98 = \pi r^2 \cdot 5$; $r^2 = \frac{98}{5\pi}$; $\sqrt{r^2} = \sqrt{\frac{98}{5\pi}}$; $r \approx 2.5$; about 2.5 in. 31. An extraneous solution is a solution of a new equation that does not satisfy the original equation. 32. Answers may vary. Sample: $x - 2 = \sqrt{7 - 2x}$, $\sqrt{3x} = 3$ 33. $t = \sqrt{\frac{n}{16}}$; $10 = \sqrt{\frac{n}{16}}$; $10^2 = \left(\sqrt{\frac{n}{16}}\right)^2$; $100 = \frac{n}{16}$; $n = 1600$; 1600 ft 34. $\sqrt{5x + 10} = 5$; $(\sqrt{5x + 10})^2 = 5^2$; $5x + 10 = 25$; $5x = 15$; $x = 3$; Check: $\sqrt{5(3) + 10} \stackrel{?}{=} 5$; $\sqrt{25} \stackrel{?}{=} 5$; $5 = 5$ 35. $-6 - \sqrt{3y} = -3$; $-3 = \sqrt{3y}$; no solution 36. $\sqrt{7p + 5} = \sqrt{p - 3}$; $(\sqrt{7p + 5})^2 = (\sqrt{p - 3})^2$; $7p + 5 = p - 3$; $6p = -8$; $p = -\frac{4}{3}$; Check: $\sqrt{7\left(-\frac{4}{3}\right) + 5} \stackrel{?}{=} \sqrt{-\frac{4}{3} - 3}$; $\sqrt{-\frac{13}{3}} \stackrel{?}{=} \sqrt{-\frac{13}{3}}$; no solution 37. $a = \sqrt{7a - 6}$; $a^2 = (\sqrt{7a - 6})^2$; $a^2 = 7a - 6$; $a^2 - 7a + 6 = 0$; $(a - 6)(a - 1) = 0$; $a - 6 = 0$ or $a - 1 = 0$; $a = 6$ or $a = 1$; Check $a = 6$: $6 \stackrel{?}{=} \sqrt{7(6) - 6}$; $6 \stackrel{?}{=} \sqrt{36}$; $6 = 6$; Check $a = 1$: $1 \stackrel{?}{=} \sqrt{7(1) - 6}$; $1 \stackrel{?}{=} \sqrt{1}$; $1 = 1$; the solutions are 1 and 6. 38. $\sqrt{y + 12} = 3\sqrt{y}$; $(\sqrt{y + 12})^2 = (3\sqrt{y})^2$; $y + 12 = 9y$; $8y = 12$; $y = 1.5$;

Check: $\sqrt{1.5 + 12} \stackrel{?}{=} 3\sqrt{1.5}$; $\sqrt{13.5} \stackrel{?}{=} 3\sqrt{1.5}$; use a calculator to see that $\sqrt{13.5} = 3\sqrt{1.5}$; the solution is 1.5. 39. $\sqrt{x - 10} = 1$; $(\sqrt{x - 10})^2 = 1^2$; $x - 10 = 1$; $x = 11$; Check: $\sqrt{11 - 10} \stackrel{?}{=} 1$; $\sqrt{1} \stackrel{?}{=} 1$; $1 = 1$; the solution is 11. 40. $\frac{x}{2} = \sqrt{3x}$; $\left(\frac{x}{2}\right)^2 = (\sqrt{3x})^2$; $\frac{x^2}{4} = 3x$; $x^2 = 12x$; $x^2 - 12x = 0$; $x(x - 12) = 0$; $x = 0$ or $x - 12 = 0$; $x = 0$ or $x = 12$; Check $x = 0$: $\frac{0}{2} \stackrel{?}{=} \sqrt{3(0)}$; $0 \stackrel{?}{=} \sqrt{0}$; $0 = 0$; Check $x = 12$: $\frac{12}{2} \stackrel{?}{=} \sqrt{3(12)}$; $6 \stackrel{?}{=} \sqrt{36}$; $6 = 6$; the solutions are 0 and 12. 41. $\frac{c}{3} = \sqrt{c - 2}$; $\left(\frac{c}{3}\right)^2 = (\sqrt{c - 2})^2$; $\frac{c^2}{9} = c - 2$; $c^2 = 9(c - 2)$; $c^2 = 9c - 18$; $c^2 - 9c + 18 = 0$; $(c - 3)(c - 6) = 0$; $c - 3 = 0$ or $c - 6 = 0$; $c = 3$ or $c = 6$; Check $c = 3$: $\frac{3}{3} \stackrel{?}{=} \sqrt{3 - 2}$; $1 \stackrel{?}{=} \sqrt{1}$; $1 = 1$; Check $c = 6$: $\frac{6}{3} \stackrel{?}{=} \sqrt{6 - 2}$; $2 \stackrel{?}{=} \sqrt{4}$; $2 = 2$; the solutions are 3 and 6. 42. $7 = \sqrt{x + 5}$; $7^2 = (\sqrt{x + 5})^2$; $49 = x + 5$; $x = 44$; Check: $7 \stackrel{?}{=} \sqrt{44 + 5}$; $7 \stackrel{?}{=} \sqrt{49}$; $7 = 7$; the solution is 44. 43. $3 - \sqrt{4a + 1} = 12$; $-9 = \sqrt{4a + 1}$; no solution 44a. $v = 8\sqrt{h - 2r}$; $30 = 8\sqrt{150 - 2r}$; $3.75 = \sqrt{150 - 2r}$; $3.75^2 = (\sqrt{150 - 2r})^2$; $14.0625 = 150 - 2r$; $2r = 135.9375$; $r \approx 68$; about 68 ft 44b. $\frac{30 \text{ ft}}{1 \text{ s}} \cdot \frac{60 \text{ s}}{1 \text{ min}} \cdot \frac{60 \text{ min}}{1 \text{ h}} \cdot \frac{1 \text{ mi}}{5280 \text{ ft}} \approx 20.5 \text{ mi/h}$ 44c. As radius increases, velocity decreases. As height decreases, velocity decreases. 44d. Velocity depends upon the difference of the height and the radius. 45a.  $y = \sqrt{2x + 1}$ and $y = \sqrt{3x - 5}$

45b. point of intersection $\approx (6, 3.6)$ 45c. $\sqrt{2x + 1} = \sqrt{3x - 5}$; $(\sqrt{2x + 1})^2 = (\sqrt{3x - 5})^2$; $2x + 1 = 3x - 5$; $x = 6$; it is the x -coordinate of the point of intersection. 46a. $V = 10 \cdot x \cdot x$; $V = 10x^2$ 46b. $V = 10x^2$; $x^2 = \frac{V}{10}$; $\sqrt{x^2} = \sqrt{\frac{V}{10}}$; $x = \sqrt{\frac{V}{10}}$ 46c. If $V = 40$, $x = \sqrt{\frac{40}{10}} = \sqrt{4} = 2$; if $V = 490$, $x = \sqrt{\frac{490}{10}} = \sqrt{49} = 7$; integer values of x : 2, 3, 4, 5, 6, 7 47a. $x^2 - 3 = 4$; $x^2 = 7$; $x = \pm\sqrt{7}$ 47b. $\sqrt{x} - 3 = 4$; $\sqrt{x} = 7$; $x = 49$ 47c. In both cases 3 is added to each side. To solve the first equation you find the square roots of each side, and in the second equation you find the square of each side. 48. $\sqrt{x^2 - 6x} = 4$; $(\sqrt{x^2 - 6x})^2 = 4^2$; $x^2 - 6x = 16$; $x^2 - 6x - 16 = 0$; $(x + 2)(x - 8) = 0$; $x + 2 = 0$ or $x - 8 = 0$; $x = -2$ or $x = 8$; Check $x = -2$: $\sqrt{(-2)^2 - 6(-2)} \stackrel{?}{=} 4$; $\sqrt{16} \stackrel{?}{=} 4$; $4 = 4$; Check $x = 8$: $\sqrt{8^2 - 6(8)} \stackrel{?}{=} 4$; $\sqrt{16} \stackrel{?}{=} 4$; $4 = 4$; the solutions are -2 and 8 . 49. $\sqrt{2x^2 + 8x} = x$; $(\sqrt{2x^2 + 8x})^2 = x^2$; $2x^2 + 8x = x^2$; $x^2 + 8x = 0$; $x(x + 8) = 0$; $x = 0$ or $x + 8 = 0$; $x = 0$ or $x = -8$; Check $x = 0$: $\sqrt{2(0)^2 + 8(0)} \stackrel{?}{=} 0$; $\sqrt{0} \stackrel{?}{=} 0$; $0 = 0$; Check $x = -8$:

$$\sqrt{2(-8)^2 + 8(-8)} \stackrel{?}{=} -8; \sqrt{64} \stackrel{?}{=} -8; 8 \neq -8;$$

the solution is 0. **50.** $\sqrt{x^2 + 4x + 5} = x$;

$$(\sqrt{x^2 + 4x + 5})^2 = x^2; x^2 + 4x + 5 = x^2; 4x = -5; x = -1.25; \text{Check: } \sqrt{(-1.25)^2 + 4(-1.25) + 5} \stackrel{?}{=} -1.25; \sqrt{1.5625} \stackrel{?}{=} -1.25; 1.25 \neq -1.25; \text{no solution}$$

$$\begin{aligned} \text{51. } x + 3 &= \sqrt{x^2 - 4x - 1}; (x + 3)^2 = \\ (\sqrt{x^2 - 4x - 1})^2 &; x^2 + 6x + 9 = x^2 - 4x - 1; 10x = -10; x = -1; \text{Check: } -1 + 3 \stackrel{?}{=} \sqrt{(-1)^2 - 4(-1) - 1}; \end{aligned}$$

$2 \stackrel{?}{=} \sqrt{4}; 2 = 2$; the solution is -1 . **52.** Subtract $\sqrt{2x}$ from each side. Square both sides. Solve for x . Check the solution if there is one. **53.** The square of $\sqrt{x - 1}$ will have only 2 terms, while $\sqrt{x - 1}$ squared will have 3

$$\begin{aligned} \text{terms. } \text{54a. } T &= \sqrt{\frac{2\pi^2 r}{F}}; 2 = \sqrt{\frac{2\pi^2 r}{10}}; 2 = \sqrt{\frac{\pi^2 r}{5}}; 2^2 = \\ \left(\sqrt{\frac{\pi^2 r}{5}}\right)^2 &; 4 = \frac{\pi^2 r}{5}; 20 = \pi^2 r; r = \frac{20}{\pi^2} \approx 2.0 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{54b. } T &= \sqrt{\frac{2\pi^2 r}{F}}; 2 = \sqrt{\frac{2\pi^2 r}{160}}; 2 = \sqrt{\frac{\pi^2 r}{80}}; 2^2 = \\ \left(\sqrt{\frac{\pi^2 r}{80}}\right)^2 &; 4 = \frac{\pi^2 r}{80}; 320 = \pi^2 r; r = \frac{320}{\pi^2} \approx 32.4 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{55. } k &= \sqrt{5k + 6}; k^2 = (\sqrt{5k + 6})^2; k^2 = \\ 5k + 6; k^2 - 5k - 6 &= 0; (k - 6)(k + 1) = 0; k - 6 = 0 \text{ or } k + 1 = 0; k = 6 \text{ or } k = -1; \text{Check } k = 6: 6 \stackrel{?}{=} \sqrt{5(6) + 6}; 6 \stackrel{?}{=} \sqrt{36}; 6 = 6; \text{Check } k = -1: -1 \stackrel{?}{=} \sqrt{5(-1) + 6}; -1 \stackrel{?}{=} \sqrt{1}; -1 \neq 1; \text{the solution is } 6; \text{C} \end{aligned}$$

$$\begin{aligned} \text{56. } \sqrt{2x + 1} &= \sqrt{3x - 5}; (\sqrt{2x + 1})^2 = (\sqrt{3x - 5})^2; \\ 2x + 1 &= 3x - 5; x = 6; \text{Check } x = 6: \sqrt{2(6) + 1} \stackrel{?}{=} \sqrt{3(6) - 5}; \sqrt{13} = \sqrt{13}; \text{the solution is } 6; \text{G} \end{aligned}$$

$$\begin{aligned} \text{57. A. } -\sqrt{x} &= -25x; \sqrt{x} = 25x; (\sqrt{x})^2 = (25x)^2; x = 625x^2; 625x^2 - x = 0; x(625x - 1) = 0; x = 0 \text{ or } 625x - 1 = 0; x = 0 \text{ or } 625x = 1; x = 0 \text{ or } x = \frac{1}{625}; \text{Check } x = 0: \sqrt{0} \stackrel{?}{=} 25(0); 0 = 0; \text{has a solution. B. } \sqrt{3x + 1} = -10; \text{no solution. C. } -3\sqrt{3x} = -5; \sqrt{3x} = \frac{5}{3}; (\sqrt{3x})^2 = \left(\frac{5}{3}\right)^2; 3x = \frac{25}{9}; 27x = 25; x = \frac{25}{27}; \text{Check: } -3\sqrt{3\left(\frac{25}{27}\right)} \stackrel{?}{=} -5; -3\sqrt{\frac{25}{9}} \stackrel{?}{=} -5; -3\left(\frac{5}{3}\right) \stackrel{?}{=} -5; -5 = -5; \text{has a} \end{aligned}$$

$$\begin{aligned} \text{solution. D. } \frac{x}{2} &= \sqrt{x - 1}; \left(\frac{x}{2}\right)^2 = (\sqrt{x - 1})^2; \frac{x^2}{4} = x - 1; x^2 = 4(x - 1); x^2 = 4x - 4; x^2 - 4x + 4 = 0; (x - 2)^2 = 0; x - 2 = 0; x = 2; \text{Check: } \frac{2}{2} \stackrel{?}{=} \sqrt{2 - 1}; 1 \stackrel{?}{=} \sqrt{1}; 1 = 1; \text{has a solution; the answer is B. } \text{58. Column A: } \sqrt{2n - 4} = 6; (\sqrt{2n - 4})^2 = 6^2; 2n - 4 = 36; 2n = 40; n = 20; \text{Column B: } \sqrt{9 - 2m} = 7; (\sqrt{9 - 2m})^2 = 7^2; 9 - 2m = 49; 2m = -40; m = -20; 20 > -20, \text{so the answer is A. } \text{59. Column A: } 0; \text{Column B: } 8 - 3\sqrt{y} = 2; 3\sqrt{y} = 6; \sqrt{y} = 2; (\sqrt{y})^2 = 2^2; y = 4; 4 > 0, \text{so the answer is B. } \text{60. Column A: } \frac{2\sqrt{3x - 9}}{3} = 4; \sqrt{3x - 9} = 6; (\sqrt{3x - 9})^2 = 6^2; 3x - 9 = 36; 3x = 45; x = 15; \end{aligned}$$

$$\text{Column B: } \frac{16}{\sqrt{a + 1}} = 4; 16 = 4\sqrt{a + 1}; \sqrt{a + 1} = 4;$$

$$(\sqrt{a + 1})^2 = 4^2; a + 1 = 16; a = 15; 15 = 15, \text{so the answer is C. } \text{61. [2]} \sqrt{15 - 5x} = \sqrt{4x - 3}; 15 - 5x = 4x - 3; -9x = -18; x = 2; \text{Check: } \sqrt{15 - 5(2)} \stackrel{?}{=} \sqrt{4(2) - 3}; \sqrt{5} = \sqrt{5}; \text{the solution is 2. [1] correct technique with a minor error OR correct answer, no work shown. } \text{62. } \sqrt{20} + \sqrt{45} = \sqrt{4 \cdot 5} + \sqrt{9 \cdot 5} = 2\sqrt{5} + 3\sqrt{5} = (2 + 3)\sqrt{5} = 5\sqrt{5} \text{ 63. } \sqrt{3}(\sqrt{6} + 4) =$$

$$\sqrt{18} + 4\sqrt{3} = \sqrt{9 \cdot 2} + 4\sqrt{3} = 3\sqrt{2} + 4\sqrt{3} \text{ 64. } \sqrt{72} - \sqrt{50} = \sqrt{36 \cdot 2} - \sqrt{25 \cdot 2} = 6\sqrt{2} - 5\sqrt{2} = (6 - 5)\sqrt{2} = 1\sqrt{2} = \sqrt{2} \text{ 65. } \sqrt{2}(2\sqrt{8} + 4\sqrt{18}) = 2\sqrt{16} + 4\sqrt{36} =$$

$$2(4) + 4(6) = 8 + 24 = 32 \text{ 66. } \frac{8}{\sqrt{5} + \sqrt{3}} = \frac{8}{\sqrt{5} + \sqrt{3}} \cdot \frac{\sqrt{5} - \sqrt{3}}{\sqrt{5} - \sqrt{3}} = \frac{8(\sqrt{5} - \sqrt{3})}{5 - 3} = \frac{8(\sqrt{5} - \sqrt{3})}{2} =$$

$$4(\sqrt{5} - \sqrt{3}) \text{ 67. } \sqrt{12}(7\sqrt{6} + \sqrt{24}) = 7\sqrt{72} + \sqrt{288} = 7\sqrt{36 \cdot 2} + \sqrt{144 \cdot 2} =$$

$$7(6)\sqrt{2} + 12\sqrt{2} = 42\sqrt{2} + 12\sqrt{2} = (42 + 12)\sqrt{2} = 54\sqrt{2} \text{ 68. } w^2 + 2w - 11 = 0; w^2 + 2w = 11; w^2 + 2w + 1 = 11 + 1; (w + 1)^2 = 12; w + 1 = \pm\sqrt{12} \approx \pm 3.5; w + 1 \approx 3.5 \text{ or } w + 1 \approx -3.5; w \approx 2.5 \text{ or } w \approx -4.5 \text{ 69. } k^2 - 8k = 3; k^2 - 8k + 16 = 3 + 16; (k - 4)^2 = 19; k - 4 = \pm\sqrt{19} \approx \pm 4.4; k - 4 \approx 4.4 \text{ or } k - 4 \approx -4.4; k \approx 8.4 \text{ or } k \approx -0.4 \text{ 70. } d^2 + 5d + 1 = 0; d^2 + 5d + \frac{25}{4} = -1 + \frac{25}{4}; \left(d + \frac{5}{2}\right)^2 = \frac{21}{4};$$

$$d + \frac{5}{2} = \pm\sqrt{\frac{21}{4}} \approx \pm 2.3; d + 2.5 \approx 2.3 \text{ or } d + 2.5 \approx -2.3; d \approx -0.2 \text{ or } d \approx -4.8 \text{ 71. } 2a^2 + 20a = 16; a^2 + 10a = 8; a^2 + 10a + 25 = 8 + 25; (a + 5)^2 = 33; a + 5 = \pm\sqrt{33} \approx \pm 5.7; a + 5 \approx 5.7 \text{ or } a + 5 \approx -5.7; a \approx 0.7 \text{ or } a \approx -10.7 \text{ 72. } \frac{1}{5}x^2 + 2x = 4; x^2 + 10x = 20; x^2 + 10x + 25 = 20 + 25; (x + 5)^2 = 45; x + 5 =$$

$$\pm\sqrt{45} \approx \pm 6.7; x + 5 \approx 6.7 \text{ or } x + 5 \approx -6.7; x \approx 1.7 \text{ or } x \approx -11.7 \text{ 73. } 6g^2 - 9g - 30 = 0; g^2 - \frac{3}{2}g = 5; g^2 - \frac{3}{2}g + \frac{9}{16} = 5 + \frac{9}{16}; \left(g - \frac{3}{4}\right)^2 = \frac{89}{16}; g - \frac{3}{4} = \pm\sqrt{\frac{89}{16}} \approx \pm 2.36; g - 0.75 \approx 2.36 \text{ or } g - 0.75 \approx -2.36; g \approx 3.1 \text{ or } g \approx -1.6 \text{ 74. } x^2 + 10x - 24 = (x + 12)(x - 2) \text{ 75. } m^2 - 14m + 13 = (m - 13)(m - 1) \text{ 76. } b^2 + 16b - 36 = (b + 18)(b - 2) \text{ 77. } 2p^2 + 15p + 7 = (2p + 1)(p + 7) \text{ 78. } 3d^2 + 12d - 15 = 3(d^2 + 4d - 5) = 3(d - 1)(d + 5) \text{ 79. } 4v^2 - 25v + 25 = (4v - 5)(v - 5)$$

READING MATH

page 613

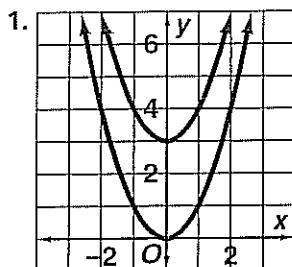
$$\text{a. } S = 6e^2 \text{ b. } 726 \leq 6e^2 \leq 1176; 121 \leq e^2 \leq 196;$$

$11 \leq e \leq 14$; integer values of e : 11, 12, 13, 14

11-6 Graphing Square Root Functions

pages 514–519

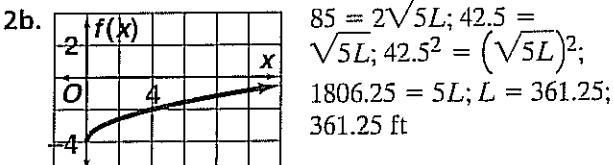
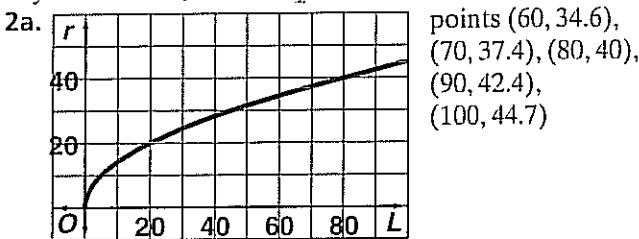
Check Skills You'll Need For complete solutions see *Daily Skills Check and Lesson Quiz Transparencies or Presentation Pro CD-ROM*.



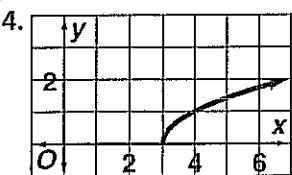
3. 2 4. 0 5. 11

Check Understanding

1. $y = \sqrt{x - 7}$; domain: $x - 7 \geq 0; x \geq 7$



3. For the graph of $f(x) = \sqrt{x} - 4$, the graph of $f(x) = \sqrt{x}$ is shifted 4 units down.

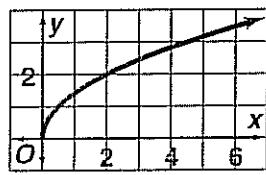


For the graph of $y = \sqrt{x - 3}$, the graph of $y = \sqrt{x}$ is shifted 3 units right.

- Exercises
- $y = \sqrt{x - 2}$; domain: $x - 2 \geq 0; x \geq 2$
 - $f(x) = \sqrt{4x - 3}$; domain: $4x - 3 \geq 0; 4x \geq 3; x \geq \frac{3}{4}$
 - $y = \sqrt{1.5x}$; domain: $1.5x \geq 0; x \geq 0$
 - $f(x) = \sqrt{7 + x}$; domain: $7 + x \geq 0; x \geq -7$
 - $y = \sqrt{x + 3} - 1$; domain: $x + 3 \geq 0; x \geq -3$
 - $f(x) = \sqrt{x - 5} + 1$; domain: $x - 5 \geq 0; x \geq 5$
 - $f(x) = \sqrt{3x + 5}$; domain: $3x + 5 \geq 0; 3x \geq -5; x \geq -\frac{5}{3}$
 - $f(x) = \sqrt{2 + x}$; domain: $2 + x \geq 0; x \geq -2$
 - $f(x) = \sqrt{6x - 8} + 1$; domain: $6x - 8 \geq 0; 6x \geq 8; x \geq \frac{4}{3}$

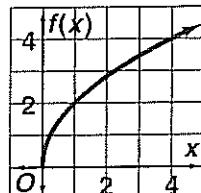
10. $y = \sqrt{2x}$

x	y
0	0
2	2
4.5	3



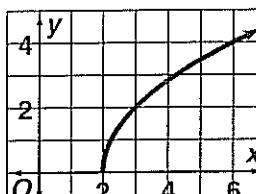
11. $f(x) = 2\sqrt{x}$

x	$f(x)$
0	0
1	2
4	4



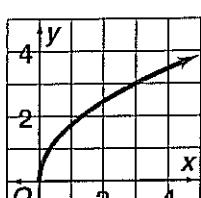
12. $y = \sqrt{4x - 8}$

x	y
2	0
3	2
6	4



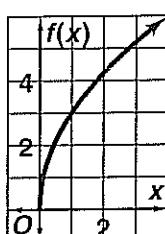
13. $y = \sqrt{3x}$

x	y
0	0
3	3
5.3	4



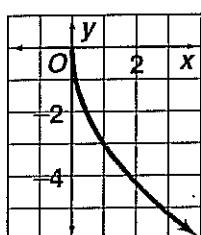
14. $f(x) = 3\sqrt{x}$

x	$f(x)$
0	0
1	3
4	6



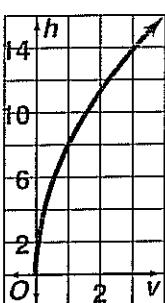
15. $y = -3\sqrt{x}$

x	y
0	0
1	-3
4	-6



16. $v = \sqrt{64h}$

h	v
0	0
1	8
4	16



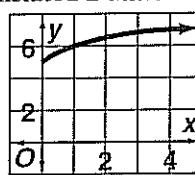
17. $y = \sqrt{x + 4}$; look for $y = \sqrt{x}$ translated 4 units left;

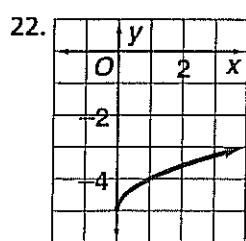
D 18. $y = \sqrt{x - 2}$; look for $y = \sqrt{x}$ translated 2 units

right; A 19. $y = \sqrt{x + 4}$; look for $y = \sqrt{x}$ translated

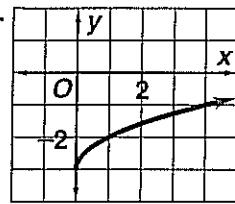
4 units up; C 20. $y = \sqrt{x - 2}$; look for $y = \sqrt{x}$ translated 2 units down; B

21. $f(x) = \sqrt{x + 5}$; $f(x) = \sqrt{x}$ translated 5 units up

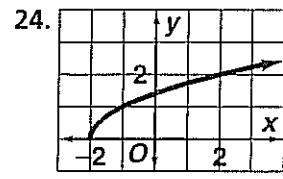




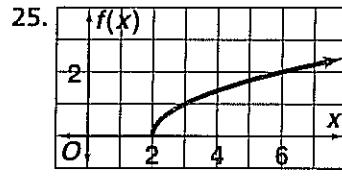
22. $y = \sqrt{x} - 5$; $y = \sqrt{x}$ translated 5 units down



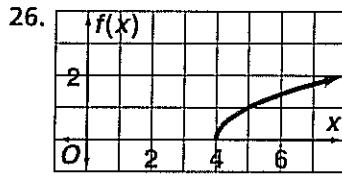
23. $y = \sqrt{x} - 3$; $y = \sqrt{x}$ translated 3 units down



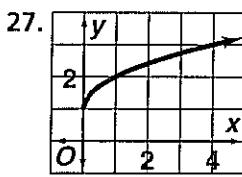
24. $y = \sqrt{x + 2}$; $y = \sqrt{x}$ translated 2 units left



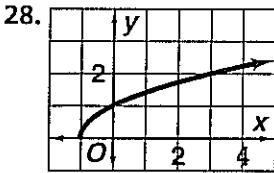
25. $f(x) = \sqrt{x - 2}$
 $f(x) = \sqrt{x}$ translated 2 units right



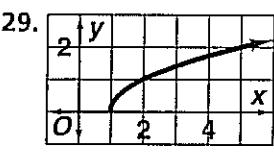
26. $f(x) = \sqrt{x - 4}$
 $f(x) = \sqrt{x}$ translated 4 units right



27. $y = \sqrt{x} + 1$; $y = \sqrt{x}$ translated 1 unit up



28. $y = \sqrt{x + 1}$; $y = \sqrt{x}$ translated 1 unit left



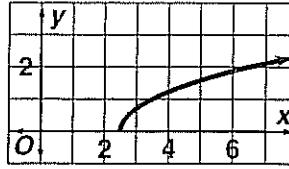
29. $y = \sqrt{x - 1}$; $y = \sqrt{x}$ translated 1 unit right

30. $y = \sqrt{2x - 8}$; domain: $2x - 8 \geq 0$; $2x \geq 8$; $x \geq 4$; range: $y \geq 0$
31. $y = \sqrt{8 - 2x}$; domain: $8 - 2x \geq 0$; $8 \geq 2x$; $4 \geq x$; $x \leq 4$; range: $y \geq 0$
32. Form an inequality setting the radicand greater than or equal to 0. Solve for x . Answers may vary. Sample: $y = \sqrt{x - 2}$; domain: $x - 2 \geq 0$; $x \geq 2$
33. Answers may vary. Samples are given.
- 33a. $y = \sqrt{x} + 2$
- 33b. $y = \sqrt{x + 2}$
- 33c. $y = 2\sqrt{x}$
- 33d. Check students' work.
34. Translate the

graph of $y = \sqrt{x}$, 8 units to the left. 35. Translate the graph of $y = \sqrt{x}$, 10 units down. 36. Translate the graph of $y = \sqrt{x}$, 12 units up. 37. Translate the graph of $y = \sqrt{x}$, 9 units right.

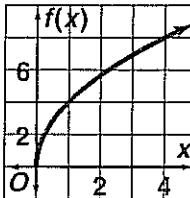
38. $y = \sqrt{x - 2.5}$

x	y
2.5	0
3.5	1
6.5	2



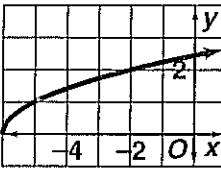
39. $f(x) = 4\sqrt{x}$

x	f(x)
0	0
1	4
2	5.7
4	8



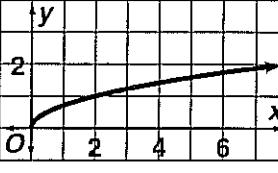
40. $y = \sqrt{x + 6}$

x	y
-6	0
-5	1
-2	2
0	2.4



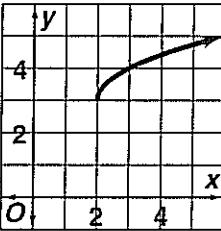
41. $y = \sqrt{0.5x}$

x	y
0	0
2	1
4	1.4
8	2



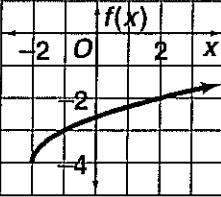
42. $y = \sqrt{x - 2} + 3$

x	y
2	3
3	4
6	5



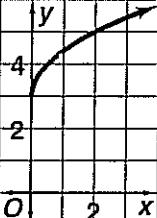
43. $f(x) = \sqrt{x + 2} - 4$

x	f(x)
-2	-4
-1	-3
2	-2



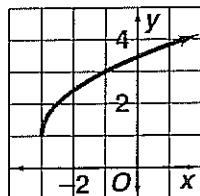
44. $y = \sqrt{2x + 3}$

x	y
0	3
1	4.4
2	5
3	5.4



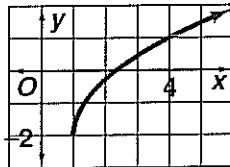
45. $y = \sqrt{2x + 6} + 1$

x	y
-3	1
-2	2.4
-1	3
0	3.4



46. $y = \sqrt{3x - 3} - 2$

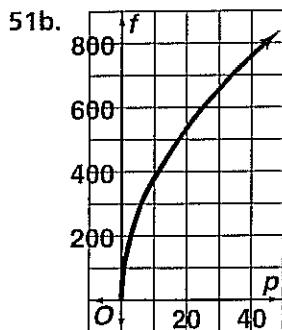
x	y
1	-2
2	-0.3
3	0.4
4	1



47. $y = \sqrt{x + 1} - 3$; look for $y = \sqrt{x}$ translated 1 unit left and 3 units down; B 48. $y = \sqrt{x - 1} + 3$; look for $y = \sqrt{x}$ translated 1 unit right and 3 units up; D

49. $y = \sqrt{x - 3} - 1$; look for $y = \sqrt{x}$ translated 3 units right and 1 unit down; A 50. $y = \sqrt{x + 3} + 1$; look for $y = \sqrt{x}$ translated 3 units left and 1 unit up; C

51a. $f = 120\sqrt{p}$; domain: $p \geq 0$



points $(0, 0)$,
 $(4, 240)$, $(16, 480)$, $(25, 600)$,
 $(36, 720)$, $(49, 840)$

51c. when $f = 800$, $p \approx 45$;
 about 45 lb/in.²

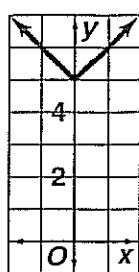
52a. No 52b. Answers may vary. Sample: The graph of $y = \sqrt{x}$ is the first quadrant of the graph of $x = y^2$.

52c. $y = -\sqrt{x}$ 53. The graph of $y = 3\sqrt{x}$ rises more steeply because $3\sqrt{x} > \sqrt{3x}$ for all positive values of x .

54. False; x must equal 81. 55. False; only combine like terms. 56. True 57. False; $x = -1$. 58a. $n = 27\sqrt{5t} + 53$; $n = 27\sqrt{5}(7) + 53 \approx 213$; about 213 cameras

58b. $175 = 27\sqrt{5t} + 53$; $122 = 27\sqrt{5t}$; $\frac{122}{27} = \sqrt{5t}$;
 $\left(\frac{122}{27}\right)^2 = (\sqrt{5t})^2$; $5t \approx 20.4$; $t \approx 4$; month 4

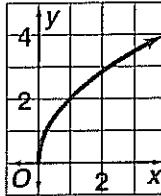
59a. $y = \sqrt{x^2 + 5}$



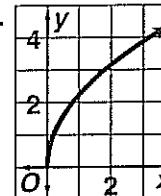
59b. $y = |x| + 5$

60. Translate the graph of $y = \sqrt{x}$ right 2 units and up 3 units.

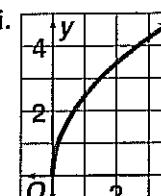
61ai. $y = \sqrt{4x}$



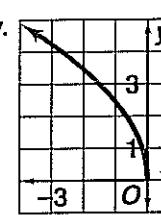
61aii. $y = \sqrt{5x}$



61aiii. $y = \sqrt{6x}$



61aiv. $y = \sqrt{-6x}$



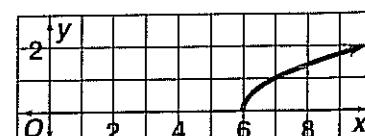
61b. The greater the absolute value of n , the steeper the graph. If $n < 0$, then the graph lies in Quadrant II. If $n > 0$, the graph lies in Quadrant I.

62. $2\sqrt{x} = \sqrt{5 - x}$; $(2\sqrt{x})^2 = (\sqrt{5 - x})^2$; $4x = 5 - x$; $5x = 5$; $x = 1$; $y = 2\sqrt{1} = 2$; (1, 2); check students' work. 63. $y = \sqrt{1 - x}$; points (1, 0), (0, 1), (-3, 2); B

64. $2x - 44 \leq 0$; $2x \leq 44$; $x \leq 22$; H 65. $y = -\sqrt{5x - 10}$; domain: $5x - 10 \geq 0$; $5x \geq 10$; $x \geq 2$; when $x = 2$, $y = -\sqrt{5(2) - 10} = -\sqrt{0} = 0$; C 66. F. $y = \sqrt{7 - (-2)} = \sqrt{9} = 3$ G. $y = \sqrt{7 + (-2)} = \sqrt{5} \approx 2.2$ H. $y = \sqrt{-(-2)} - 7 = \sqrt{2} - 7 \approx -5.6$ I. $y = \sqrt{-(-2)} + 7 = \sqrt{2} + 7 \approx 8.4$; the answer is H. 67. $\frac{a}{b} = \frac{\sqrt{6}}{c}$ with $a = \sqrt{24}$; $\frac{\sqrt{24}}{b} = \frac{\sqrt{6}}{c}$; $c\sqrt{24} = b\sqrt{6}$; $\frac{c}{b} = \frac{\sqrt{6}}{\sqrt{24}} = \sqrt{\frac{6}{24}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$; B 68. $y = \sqrt{x} + 7$ is the graph of $y = \sqrt{x}$ translated 7 units up, so it is in Quadrant I only; H

69. [2] $y = \sqrt{x - 6}$

x	y
6	0
7	1
8	1.4
9	1.7
10	2



[1] incorrect coordinates on graph

70. $\sqrt{x} + 7 = 11$; $\sqrt{x} = 4$; $(\sqrt{x})^2 = 4^2$; $x = 16$;

Check: $\sqrt{16} + 7 = 11$; $4 + 7 = 11$; the solution is 16.

71. $\sqrt{c+1} = \sqrt{2c-6}$; $(\sqrt{c+1})^2 = (\sqrt{2c-6})^2$; $c+1 = 2c-6$; $7 = c$; Check: $\sqrt{7+1} = \sqrt{2(7)-6}$; $\sqrt{8} = \sqrt{8}$; the solution is 7.
72. $\sqrt{x}-4=9$; $\sqrt{x}=13$; $(\sqrt{x})^2=13^2$; $x=169$; Check: $\sqrt{169}-4=9$; $13-4=9$; the solution is 169.
73. $13=5\sqrt{m-8}$; $\sqrt{m-8}=\frac{13}{5}$; $(\sqrt{m-8})^2=\left(\frac{13}{5}\right)^2$; $m-8=\frac{169}{25}$; $m=\frac{169}{25}+8=14.76$; Check: $13=\sqrt{14.76-8}$; $13=5(2.6)$; $13=13$; the solution is 14.76.
74. $\sqrt{k+3}+12=6$; $\sqrt{k+3}=-6$; no solution
75. $\sqrt{5h-2}=\sqrt{2h}$; $(\sqrt{5h-2})^2=(\sqrt{2h})^2$; $5h-2=2h$; $3h=2$; $h=\frac{2}{3}$; Check: $\sqrt{5\left(\frac{2}{3}\right)}-2=\sqrt{2\left(\frac{2}{3}\right)}$; $\sqrt{\frac{4}{3}}=\sqrt{\frac{4}{3}}$; the solution is $\frac{2}{3}$.
76. $2x^2+4x-7=0$; $a=2$, $b=4$, $c=-7$; $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=\frac{-4\pm\sqrt{4^2-4(2)(-7)}}{2(2)}=\frac{-4\pm\sqrt{72}}{4}=\frac{-4\pm6\sqrt{2}}{4}=\frac{-2\pm3\sqrt{2}}{2}$; $\frac{-2+3\sqrt{2}}{2}$, $\frac{-2-3\sqrt{2}}{2}$
77. $x^2-8x-23=0$; $a=1$, $b=-8$, $c=-23$; $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=\frac{-(-8)\pm\sqrt{(-8)^2-4(1)(-23)}}{2(1)}=\frac{8\pm\sqrt{156}}{2}=\frac{8\pm2\sqrt{39}}{2}=4\pm\sqrt{39}$; $4+\sqrt{39}$, $4-\sqrt{39}$
78. $5x^2-x+11=0$; $a=5$, $b=-1$, $c=11$; $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=\frac{-(-1)\pm\sqrt{(-1)^2-4(5)(11)}}{2(5)}=\frac{1\pm\sqrt{-219}}{10}$; no solution
79. $9x^2+6x-10=0$; $a=9$, $b=6$, $c=-10$; $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=\frac{-6\pm\sqrt{6^2-4(9)(-10)}}{2(9)}=\frac{-6\pm\sqrt{396}}{18}=\frac{-6\pm6\sqrt{11}}{18}=\frac{-1\pm\sqrt{11}}{3}$, $\frac{-1+\sqrt{11}}{3}$, $\frac{-1-\sqrt{11}}{3}$
80. $1.2x^2+x+6=0$; $a=1.2$, $b=1$, $c=6$; $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=\frac{-1\pm\sqrt{1^2-4(1.2)(6)}}{2(1.2)}=\frac{-1\pm\sqrt{-27.8}}{2.4}$; no solution
81. $9x^2+13x-7=0$; $a=9$, $b=13$, $c=-7$; $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=\frac{-13\pm\sqrt{13^2-4(9)(-7)}}{2(9)}=\frac{-13\pm\sqrt{421}}{18}, \frac{-13+\sqrt{421}}{18}, \frac{-13-\sqrt{421}}{18}$
82. $2x^2-7x-4=(2x+1)(x-4)$
83. $3x^2+x-10=(3x-5)(x+2)$
84. $4x^2+20x+9=(2x+1)(2x+9)$
85. $2x^2-10x-48=2(x-8)(x+3)$
86. $4x^2-4x-60=4(x^2-x-15)$
87. $x^3-12x^2-13x=x(x^2-12x-13)=x(x-13)(x+1)$

CHECKPOINT QUIZ 2

page 619

- $-10\sqrt{7}+2\sqrt{7}=(-10+2)\sqrt{7}=-8\sqrt{7}$
- $\sqrt{16}-5\sqrt{2}=4-5\sqrt{2}$
- $3.2\sqrt{5}+3\sqrt{25}=2\sqrt{5}+15$
- $4.\sqrt{6}(\sqrt{12}-\sqrt{3})=\sqrt{72}-\sqrt{18}=\sqrt{36\cdot 2}-\sqrt{9\cdot 2}=6\sqrt{2}-3\sqrt{2}$

5. $(\sqrt{3}+\sqrt{2})(\sqrt{3}+\sqrt{2})=\sqrt{9}+\sqrt{6}+\sqrt{6}+\sqrt{4}=3+2\sqrt{6}+2=5+2\sqrt{6}$
6. $\frac{\sqrt{8}-\sqrt{27}}{\sqrt{6}-\sqrt{5}}=\frac{\sqrt{8}-\sqrt{27}}{\sqrt{6}-\sqrt{5}}\cdot\frac{\sqrt{6}+\sqrt{5}}{\sqrt{6}+\sqrt{5}}=\frac{\sqrt{48}+\sqrt{40}-\sqrt{162}}{6-5}=\sqrt{16\cdot 3}+\sqrt{4\cdot 10}-\sqrt{81\cdot 2}-\sqrt{9\cdot 15}=4\sqrt{3}+2\sqrt{10}-9\sqrt{2}-3\sqrt{15}$
7. $4-\sqrt{m}=-12$
8. $\sqrt{m}=16$; $(\sqrt{m})^2=16^2$, $m=256$
9. $r=\sqrt{4r+5}$; $r^2=(\sqrt{4r+5})^2$; $r^2=4r+5$; $r^2-4r-5=0$; $(r-5)(r+1)=0$; $r-5=0$ or $r+1=0$; $r=5$ or $r=-1$ (extraneous); $r=5$
- 10.
- For the graph of $y=\sqrt{x+2}$, translate the graph of $y=\sqrt{x}$ 2 units left.

EXTENSION

page 620

- $100^{\frac{1}{2}}=\sqrt{100}=10$
- $25^{\frac{1}{2}}=\sqrt{25}=5$
- $8^{\frac{1}{3}}=\sqrt[3]{8}=2$
- $4.\left(49^{\frac{1}{2}}\right)^3=(\sqrt{49})^3=7^3=343$
- $5.\left(8^{\frac{1}{3}}\right)^2=(\sqrt[3]{8})^2=2^2=4$
- $6.8^{\frac{4}{3}}=\left(8^{\frac{1}{3}}\right)^4=(\sqrt[3]{8})^4=2^4=16$
- $7.25^{\frac{3}{2}}=(25^{\frac{1}{2}})^3=(\sqrt{25})^3=5^3=125$
- $8.64^{\frac{4}{3}}=\left(64^{\frac{1}{3}}\right)^4=(\sqrt[3]{64})^4=4^4=256$
- $9.\left(x^{\frac{1}{3}}\right)^6=x^{\frac{6}{3}}=x^2$
- $10.\left(b^{\frac{1}{4}}\right)^4=b^1=b$
- $11.\left(m^{\frac{2}{5}}\right)^{\frac{5}{3}}=m^{\frac{10}{15}}=m^{\frac{2}{3}}$
- $12.\left(m^{\frac{2}{5}}\right)\left(m^{\frac{3}{5}}\right)=m^{\frac{2}{5}+\frac{3}{5}}=m^{\frac{5}{5}}=m^1=m$
- $13.\left(a^{\frac{1}{3}}\right)\left(a^{\frac{5}{6}}\right)=a^{\frac{1}{3}+\frac{5}{6}}=a^{\frac{7}{6}}$
- $14.\left(k^{\frac{1}{2}}\right)\left(k^{\frac{3}{4}}\right)^3=\left(k^{\frac{1}{2}}\right)\left(k^{\frac{3}{4}}\right)=k^{\frac{1}{2}+\frac{3}{4}}=k^{\frac{5}{4}}$
- $15.\left(36y^7\right)^{\frac{3}{2}}=36^{\frac{3}{2}}\cdot y^{\frac{21}{2}}=(\sqrt{36})^3\cdot y^{\frac{21}{2}}=6^3y^{\frac{21}{2}}=216y^{\frac{21}{2}}$
- $16.\left(81c^8\right)^{\frac{3}{4}}=81^{\frac{3}{4}}\cdot c^6=(\sqrt[4]{81})^3\cdot c^6=3^3\cdot c^6=27c^6$

11-7 Trigonometric Ratios

pages 621-627

Check Skills You'll Need For complete solutions see Daily Skills Check and Lesson Quiz Transparencies or Presentation Pro CD-ROM.

- $\frac{3}{5}, \frac{4}{5}, \frac{4}{3}$
- $\frac{5}{13}, \frac{12}{13}, \frac{12}{5}$
- 20
- 6.8
- 25
- 7.28

Investigation 1. Check students' work.

2. Answers may vary. Sample:

Triangle	a	b	c	$\frac{a}{b}$	$\frac{a}{c}$	$\frac{b}{c}$
First	3	4	5	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{4}{5}$
Second	6	8	10	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{4}{5}$

3. For both triangles, corresponding ratios are equal.

Check Understanding 1a. $\sin B = \frac{\text{opposite leg}}{\text{hypotenuse}} = \frac{12}{13}$;
 $\cos B = \frac{\text{adjacent leg}}{\text{hypotenuse}} = \frac{5}{13}$; $\tan B = \frac{\text{opposite leg}}{\text{adjacent leg}} = \frac{12}{5}$

1b. They are equal. 2a. $\sin 70^\circ = 0.9397$ 2b. $\cos 70^\circ \approx 0.3420$ 2c. $\tan 70^\circ \approx 2.7475$ 3a. $\sin 35^\circ = \frac{x}{12}$;
 $x = 12 \sin 35^\circ \approx 6.9$ 3b. $\tan 42^\circ = \frac{5}{x}$; $x \tan 42^\circ = 5$;
 $x = \frac{5}{\tan 42^\circ} \approx 5.6$

4.
 $\tan 42^\circ = \frac{x}{300}$;
 $x = 300 \tan 42^\circ \approx 270$;
about 270 ft

5. $\tan 2^\circ = \frac{26,000}{x}$; $x \tan 2^\circ = 26,000$; $x = \frac{26,000}{\tan 2^\circ} \approx 745,000$;
about 745,000 ft

Exercises 1. $\sin R = \frac{\text{opposite leg}}{\text{hypotenuse}} = \frac{6}{10} = \frac{3}{5}$
2. $\cos R = \frac{\text{adjacent leg}}{\text{hypotenuse}} = \frac{8}{10} = \frac{4}{5}$ 3. $\tan R = \frac{\text{opposite leg}}{\text{adjacent leg}} = \frac{6}{8} = \frac{3}{4}$
4. $\sin S = \frac{\text{opposite leg}}{\text{hypotenuse}} = \frac{8}{10} = \frac{4}{5}$ 5. $\cos S = \frac{\text{adjacent leg}}{\text{hypotenuse}} = \frac{6}{10} = \frac{3}{5}$ 6. $\tan S = \frac{\text{opposite leg}}{\text{adjacent leg}} = \frac{8}{6} = \frac{4}{3}$
7. $\sin 32^\circ \approx 0.5299$ 8. $\cos 55^\circ \approx 0.5736$ 9. $\tan 52^\circ \approx 1.2799$ 10. $\sin 85^\circ \approx 0.9962$ 11. $\cos 15^\circ \approx 0.9659$
12. $\cos 67^\circ = \frac{x}{14}$; $x = 14 \cos 67^\circ \approx 5.5$ 13. $\sin 48^\circ = \frac{x}{14}$;
 $x = 14 \sin 48^\circ \approx 10.4$ 14. $\tan 32^\circ = \frac{x}{5}$; $x \tan 32^\circ = 12$;
 $x = \frac{12}{\tan 32^\circ} \approx 19.2$ 15. $\sin 41^\circ = \frac{25}{x}$; $x \sin 41^\circ = 25$;
 $x = \frac{25}{\sin 41^\circ} \approx 38.1$ 16. $\cos 32^\circ = \frac{56}{x}$; $x \cos 32^\circ = 56$;
 $x = \frac{56}{\cos 32^\circ} \approx 66.0$ 17. $\tan 36^\circ = \frac{x}{29}$; $x = 29 \tan 36^\circ \approx 21.1$

18.
 $\tan 21^\circ = \frac{x}{5.1}$;
 $x = 5.1 \tan 21^\circ \approx 2.0$;
about 2.0 mi

19.
 $\tan 65^\circ = \frac{x}{80}$; $x = 80 \tan 65^\circ \approx 172$;
about 172 ft

20.
 $\tan 58^\circ = \frac{x}{510}$;
 $x = 510 \tan 58^\circ \approx 816$;
about 816 ft

21.
 $\sin 8^\circ = \frac{x}{2.6}$;
 $x = 2.6 \sin 8^\circ \approx 0.4$;
about 0.4 mi

22. $20^2 + 21^2 = c^2$; $400 + 441 = c^2$; $841 = c^2$; $c = 29$;
 $\sin A = \frac{21}{29}$; $\cos A = \frac{20}{29}$; $\tan A = \frac{21}{20}$ 23. $8^2 + b^2 = 17^2$;
 $64 + b^2 = 289$; $b^2 = 225$; $b = 15$; $\sin A = \frac{8}{17}$; $\cos A = \frac{15}{17}$;
 $\tan A = \frac{8}{15}$ 24. $a^2 + 10^2 = 26^2$; $a^2 + 100 = 676$; $a^2 = 576$;
 $a = 24$; $\sin A = \frac{24}{26} = \frac{12}{13}$; $\cos A = \frac{10}{26} = \frac{5}{13}$; $\tan A = \frac{24}{10} = \frac{12}{5}$

25.
 $\tan 40^\circ = \frac{5}{AC}$;
 $AC \tan 40^\circ = 5$;
 $AC = \frac{5}{\tan 40^\circ} \approx 6$;
 $\sin 40^\circ = \frac{5}{AB}$;
 $AB \sin 40^\circ = 5$;
 $AB = \frac{5}{\sin 40^\circ} \approx 8$

26.
 $\cos 32^\circ = \frac{42}{AC}$;
 $AC = 42 \cos 32^\circ \approx 36$;
 $\sin 32^\circ = \frac{BC}{42}$;
 $BC = 42 \sin 32^\circ \approx 22$

27.
 $\tan 71^\circ = \frac{17}{BC}$; $BC \tan 71^\circ = 17$;
 $BC = \frac{17}{\tan 71^\circ} \approx 6$;
 $\sin 71^\circ = \frac{17}{AB}$; $AB \sin 71^\circ = 17$;
 $AB = \frac{17}{\sin 71^\circ} \approx 18$

28.
 $\tan 5^\circ = \frac{AC}{50}$; $AC = 50 \tan 5^\circ \approx 4$;
 $\cos 5^\circ = \frac{50}{AB}$; $AB \cos 5^\circ = 50$;
 $AB = \frac{50}{\cos 5^\circ} \approx 50$

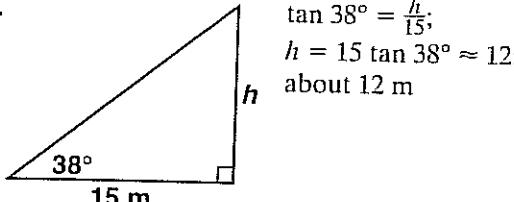
29.
 $\sin 65^\circ = \frac{h}{60}$; $h = 60 \sin 65^\circ \approx 54$;
 $54 + 1 = 55$; about 55 m

30.
 $\tan 47^\circ = \frac{h}{4.1}$; $h = 4.1 \tan 47^\circ \approx 4.4$;
about 4.4 m

31a.

$\tan 1^\circ = \frac{30,000}{d}; d \tan 1^\circ = 30,000; d = \frac{30,000}{\tan 1^\circ} \approx 1,720,000;$
about 1,720,000 ft 31b. $1,720,000 \text{ ft} \cdot \frac{1 \text{ mi}}{5280 \text{ ft}} \approx 326 \text{ mi}$

32.

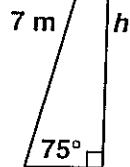


$$\tan 38^\circ = \frac{h}{15};$$

$$h = 15 \tan 38^\circ \approx 12; \text{ about } 12 \text{ m}$$

33.

$$\sin 75^\circ = \frac{h}{7}; h = 7 \sin 75^\circ \approx 6.8; \text{ about } 6.8 \text{ m}$$



34. $12^\circ + 21^\circ = 33^\circ; \tan 33^\circ = \frac{p}{792}; p = 792 \tan 33^\circ \approx 514.3$ 35. $\sin 53^\circ = \frac{m}{5.65}; m = 5.65 \sin 53^\circ \approx 4.5$

36. $\sin 49^\circ = \frac{59.2}{n}; n \sin 49^\circ = 59.2; n = \frac{59.2}{\sin 49^\circ} \approx 78.4$

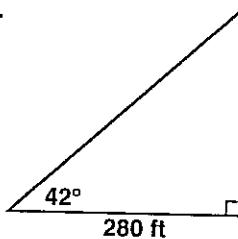
37. $\tan 17^\circ = \frac{q}{20}; q = 20 \tan 17^\circ \approx 6.1; 17^\circ + 18^\circ = 35^\circ;$
 $\tan 35^\circ = \frac{q+r}{20}; q+r = 20 \tan 35^\circ \approx 14.0; r \approx$

14.0 - 6.1 = 7.9 38a. $\tan 60^\circ = \frac{h}{102}; h = 102 \tan 60^\circ \approx 177;$
about 177 ft 38b. $177 - 91 = 86$; about 86 ft

39a.

$$\tan 42^\circ = \frac{h}{280};$$

$$h = 280 \tan 42^\circ \approx 252; \text{ about } 252 \text{ ft}$$



39b. $\cos 42^\circ = \frac{280}{x}; x \cos 42^\circ = 280; x = \frac{280}{\cos 42^\circ} \approx 377;$
about 377 ft

40. Answers may vary.

Sample:

$$\tan 70^\circ = \frac{x}{3}; x = 3 \tan 70^\circ \approx 8.2;$$

$$\text{about } 8.2 \text{ cm}$$



41.

$\tan 48^\circ = \frac{225}{x};$
 $x \tan 48^\circ = 225;$
 $x = \frac{225}{\tan 48^\circ} \approx 203;$
about 203 ft

42. $\tan 38^\circ = \frac{x}{7500}; x =$
 $7500 \tan 38^\circ \approx 5860;$
 $5860 + 78 = 5938;$
about 5938 m

43.

$$\sin 5^\circ = \frac{x}{5}; x \sin 5^\circ = 5; x = \frac{5}{\sin 5^\circ} \approx 57; \text{ about } 57 \text{ ft}$$

44.

$$\tan 45^\circ = \frac{h}{x} = 1, \text{ so } h = x; \tan 30^\circ = \frac{h}{x+400} =$$

$$\frac{x}{x+400};$$

$$(x+400) \cdot \tan 30^\circ = x;$$

$$x \tan 30^\circ + 400 \tan 30^\circ =$$

$$x; 400 \tan 30^\circ =$$

$$x - x \tan 30^\circ;$$

$400 \tan 30^\circ = x(1 - \tan 30^\circ); \frac{400 \tan 30^\circ}{1 - \tan 30^\circ} = x; x \approx 550;$
about 550 ft

45.

slope of line = $\frac{b}{a} = \tan 14^\circ \approx 0.25$

46a.

$\sin 3^\circ = \frac{12}{x}; x \sin 3^\circ = 12; x = \frac{12}{\sin 3^\circ} \approx 229; \text{ about } 229 \text{ km}$

46b.

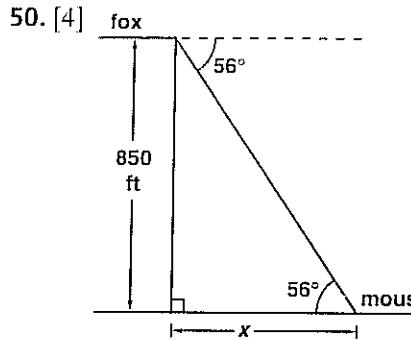
$\sin 2^\circ = \frac{x}{229}; x = 229 \sin 2^\circ \approx 8; 12 - 8 = 4; \text{ about } 4 \text{ km}$

47. $\cos 40^\circ = \frac{x}{14.2}; x = 14.2 \cos 40^\circ \approx 10.9; C$

48.

$\cos K = \frac{KL}{KM}$ is false, since
 $\cos K = \frac{KM}{KL}$; the answer
is G.

49. [2] $\sin A = \frac{7.4}{11.8} \approx 0.6271; \cos A = \frac{9.3}{11.8} \approx 0.7881;$
 $\tan A = \frac{7.4}{9.3} \approx 0.7957$ [1] at least one correct equation



$\tan 56^\circ = \frac{850}{x}$,
 $x \tan 56^\circ = 850$;
 $x = \frac{850}{\tan 56^\circ} \approx 573$;
 about 573 ft
 [3] correct
 equation, but
 minor
 computational
 error [2] incorrect
 equation used
 [1] no work shown

51. $y = \sqrt{5x}$

52. $y = \sqrt{x + 3}$

53. $y = \sqrt{x - 7}$

54. $2x^2 - x - 4 = 0$; $b^2 - 4ac = (-1)^2 - 4(2)(-4) = 1 + 32 = 33 > 0$; 2 real solutions 55. $7x^2 + x + 20 = 0$;
 $b^2 - 4ac = 1^2 - 4(7)(20) = 1 - 560 = -559 < 0$;
 0 real solutions 56. $9x^2 + 6x + 1 = 0$; $b^2 - 4ac = 6^2 - 4(9)(1) = 36 - 36 = 0$; 1 real solution
 57. $n^2 - 400 = (n - 20)(n + 20)$ 58. $x^2 - 30x + 225 = (x - 15)(x - 15) = (x - 15)^2$ 59. $100p^2 - 49 = (10p - 7)(10p + 7)$ 60. $\frac{1}{16}d^2 - \frac{9}{4} = \left(\frac{1}{4}d - \frac{3}{2}\right)\left(\frac{1}{4}d + \frac{3}{2}\right)$
 61. $98w^2 - 128 = 2(49w^2 - 64) = 2(7w - 8)(7w + 8)$ 62. $x^2 + 26x + 169 = (x + 13)(x + 13) = (x + 13)^2$

TEST-TAKING STRATEGIES page 628

1. $a^2 + b^2 = c^2$; $8^2 + 9^2 = c^2$; $64 + 81 = c^2$, $145 = c^2$; $c \approx 12$, since $12^2 = 144$; D 2. Let x = length of the other leg;
 $x^2 + 3^2 = 13^2$; $x^2 + 9 = 169$; $x^2 = 160$; $x \approx 12.6$. A = $\frac{1}{2}bh \approx \frac{1}{2} \cdot 12.6 \cdot 3 = 18.9$; G 3. $A = \pi r^2$; $118 = \pi r^2$;
 $r^2 = \frac{118}{\pi}$; $r = \sqrt{\frac{118}{\pi}} \approx 6$; B 4. $(\sqrt{3} + 3)(\sqrt{3} - 1) \approx (1.7 + 3)(1.7 - 1) = (4.7)(0.7) \approx 3.29$ 5. $\sqrt{8} = 2\sqrt{2} \approx 2(1.4) = 2.8$ 6. $\sqrt{12} = 2\sqrt{3} \approx 2(1.7) = 3.4$

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1. Two radical expressions that are the sum and the difference of the same two terms are conjugates.
 2. The two sides of a right triangle that form the right angle are the legs.
 3. One method of simplifying a radical expression is to rationalize the denominator.

4. An extraneous solution is a value that satisfies the new equation but not the original equation.

5. Radicals with the same radicand are like radicals.

6. The Pythagorean Theorem states that in a right triangle with sides a , b , and c , in which the longest side is c , $a^2 + b^2 = c^2$.

7. In a right triangle, the sine is the trigonometric ratio of the length of the leg opposite an angle to the length of the hypotenuse of the triangle.

8. A horizontal and the line of sight to an object above the horizontal form an angle of elevation.

9. The expression $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ is part of the distance formula, which determines the length of the line from point (x_1, y_1) to point (x_2, y_2) .

10. The coordinates $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$ identify the midpoint between points (x_1, y_1) and (x_2, y_2) .

11. $\sqrt{32} \cdot \sqrt{144} = \sqrt{32 \cdot 144} = \sqrt{4608} =$

$\sqrt{2304} \cdot \sqrt{2} = 48\sqrt{2}$ 12. $\sqrt{\frac{84}{121}} = \frac{\sqrt{4 \cdot 21}}{11} = \frac{2\sqrt{21}}{11}$

13. $\sqrt{96c^3} \cdot \sqrt{25c} = \sqrt{96c^3 \cdot 25c} = \sqrt{2400c^4} = \sqrt{400c^4 \cdot 6} = 20c^2\sqrt{6}$ 14. $\frac{10}{\sqrt{13}} = \frac{10}{\sqrt{13}} \cdot \frac{\sqrt{13}}{\sqrt{13}} = \frac{10\sqrt{13}}{13}$

15. $A = \ell w$; $1400 = 7w \cdot w$; $200 = w^2$; $w = \sqrt{200} = \sqrt{100 \cdot 2} = 10\sqrt{2}$; $7w = 7(10\sqrt{2}) = 70\sqrt{2}$; $10\sqrt{2}$ cm by $70\sqrt{2}$ cm 16. $a^2 + b^2 = c^2$; $3^2 + 5^2 = c^2$; $9 + 25 = c^2$; $34 = c^2$; $\sqrt{34} = \sqrt{c^2}$; $c \approx 5.8$ 17. $a^2 + b^2 = c^2$;

$11^2 + 14^2 = c^2$; $121 + 196 = c^2$; $317 = c^2$; $\sqrt{317} = \sqrt{c^2}$; $c \approx 17.8$ 18. $a^2 + b^2 = c^2$; $7^2 + 13^2 = c^2$; $49 + 169 = c^2$; $218 = c^2$; $\sqrt{218} = \sqrt{c^2}$; $c \approx 14.8$ 19. $a^2 + b^2 = c^2$;

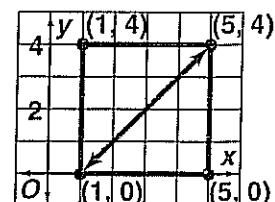
$4^2 + 9^2 = c^2$; $16 + 81 = c^2$; $97 = c^2$; $\sqrt{97} = \sqrt{c^2}$; $c \approx 9.8$ 20. $16^2 + 30^2 \stackrel{?}{=} 34^2$; $256 + 900 \stackrel{?}{=} 1156$; $1156 = 1156$; yes 21. $0.7^2 + 2.4^2 \stackrel{?}{=} 2.5^2$; $0.49 + 5.76 \stackrel{?}{=} 6.25$; $6.25 = 6.25$; yes 22. $60^2 + 60^2 = x^2$; $3600 + 3600 = x^2$; $7200 = x^2$; $\sqrt{7200} = \sqrt{x^2}$; $x \approx 85$; about 85 ft

23. $d = \sqrt{(1 - 4)^2 + (4 - 0)^2} = \sqrt{(-3)^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$ units 24. $d =$

$\sqrt{(-4 - (-2))^2 + (5 - (-3))^2} = \sqrt{(-2)^2 + 8^2} = \sqrt{4 + 64} = \sqrt{68} \approx 8.2$ units

25. $d = \sqrt{(6 - (-3))^2 + (-4 - 2)^2} = \sqrt{9^2 + (-6)^2} = \sqrt{81 + 36} = \sqrt{117} \approx 10.8$ units

26. Answers may vary. Sample:
 $d = \sqrt{(5 - 1)^2 + (4 - 0)^2} = \sqrt{4^2 + 4^2} = \sqrt{16 + 16} = \sqrt{32} \approx 5.7$ units



27. midpoint = $\left(\frac{3 + (-2)}{2}, \frac{7 + 4}{2}\right) = \left(\frac{1}{2}, \frac{11}{2}\right) = (0.5, 5.5)$

28. midpoint = $\left(\frac{4\frac{3}{4} + 6\frac{1}{4}}{2}, \frac{-2 + 10\frac{1}{2}}{2}\right) = \left(\frac{11}{2}, \frac{17}{4}\right) = \left(5\frac{1}{2}, 4\frac{1}{4}\right)$

29. $6\sqrt{7} - 2\sqrt{28} = 6\sqrt{7} - 2\sqrt{4 \cdot 7} = 6\sqrt{7} - 2(2)\sqrt{7} = 6\sqrt{7} - 4\sqrt{7} = (6 - 4)\sqrt{7} = 2\sqrt{7}$

30. $5(\sqrt{20} + \sqrt{80}) = 5(\sqrt{4 \cdot 5} + \sqrt{16 \cdot 5}) =$

$5(2\sqrt{5} + 4\sqrt{5}) = 5(6\sqrt{5}) = 30\sqrt{5}$

31. $\sqrt{54} - 2\sqrt{6} = \sqrt{9 \cdot 6} - 2\sqrt{6} = 3\sqrt{6} - 2\sqrt{6} =$

$(3 - 2)\sqrt{6} = 1\sqrt{6} = \sqrt{6}$ 32. $\sqrt{125} - 3\sqrt{5} =$

$\sqrt{25 \cdot 5} - 3\sqrt{5} = 5\sqrt{5} - 3\sqrt{5} = (5 - 3)\sqrt{5} = 2\sqrt{5}$

33. $\sqrt{10}(\sqrt{10} - \sqrt{20}) = \sqrt{100} - \sqrt{200} =$

$10 - \sqrt{100 \cdot 2} = 10 - 10\sqrt{2}$

34. $(\sqrt{2} + \sqrt{7})(3\sqrt{2} - \sqrt{7}) =$

$3\sqrt{4} - \sqrt{14} + 3\sqrt{14} - \sqrt{49} =$

$3(2) + (-1 + 3)\sqrt{14} - 7 = 6 + 2\sqrt{14} - 7 =$

$-1 + 2\sqrt{14}$ 35. $(\sqrt{5} + 4\sqrt{3})^2 =$

$(\sqrt{5} + 4\sqrt{3})(\sqrt{5} + 4\sqrt{3}) =$

$\sqrt{25} + 4\sqrt{15} + 4\sqrt{15} + 16\sqrt{9} =$

$5 + (4 + 4)\sqrt{15} + 16(3) = 5 + 8\sqrt{15} + 48 =$

$53 + 8\sqrt{15}$ 36. $\sqrt{28} + 5\sqrt{63} = \sqrt{4 \cdot 7} + 5\sqrt{9 \cdot 7} =$

$2\sqrt{7} + 5(3)\sqrt{7} = 2\sqrt{7} + 15\sqrt{7} = (2 + 15)\sqrt{7} =$

$17\sqrt{7}$ 37. $\frac{3}{\sqrt{6} - \sqrt{3}} = \frac{3}{\sqrt{6} - \sqrt{3}} \cdot \frac{\sqrt{6} + \sqrt{3}}{\sqrt{6} + \sqrt{3}} =$

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

38. $\sqrt{x+7} = 3; (\sqrt{x+7})^2 = 3^2; x+7 = 9; x = 2$

39. $\sqrt{x} + 3\sqrt{x} = 16; (1+3)\sqrt{x} = 16; 4\sqrt{x} = 16;$

$\sqrt{x} = 4; (\sqrt{x})^2 = 4^2; x = 16$ 40. $\sqrt{x+7} =$

$\sqrt{2x-1}; (\sqrt{x+7})^2 = (\sqrt{2x-1})^2; x+7 = 2x-1;$

$-x = -8; x = 8$ 41. $\sqrt{x-5} = 4; \sqrt{x} = 9; (\sqrt{x})^2 = 9^2;$

$x = 81$ 42. $\sqrt{4x} = x-3$; Check $x = 1$: $\sqrt{4(1)} \stackrel{?}{=} 1-3$;

$\sqrt{4} \stackrel{?}{=} -2$; $2 \neq -2$; 1 is an extraneous solution; Check

$x = 9$: $\sqrt{4(9)} \stackrel{?}{=} 9-3$; $\sqrt{36} \stackrel{?}{=} 6$; 6 is a solution; 1

43. $\sqrt{d-3} = 5-d$; Check $d = 4$: $\sqrt{4-3} \stackrel{?}{=} 5-4$;

$\sqrt{1} \stackrel{?}{=} 1$; 1 = 1; 4 is a solution; Check $d = 7$: $\sqrt{7-3} \stackrel{?}{=} 5-7$;

$\sqrt{4} \stackrel{?}{=} -2$; $2 \neq -2$; 7 is an extraneous solution; 7

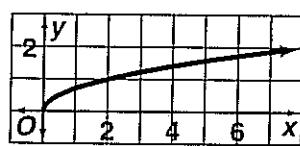
44. $50 = 2\sqrt{5} \cdot x$; $x = \frac{50}{2\sqrt{5}} = \frac{25}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{25\sqrt{5}}{5} = 5\sqrt{5}$;

$5\sqrt{5}$ cm 45. $V = \pi r^2 h$; $54 = \pi r^2 \cdot 2$; $\pi r^2 = 27$;

$r^2 = \frac{27}{\pi}$; $r = \sqrt{\frac{27}{\pi}} \approx 2.93$; about 2.93 in.

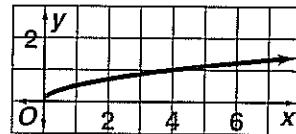
46. $y = \sqrt{\frac{x}{2}}$

x	y
0	0
0.5	0.5
2	1
4	1.4
8	2



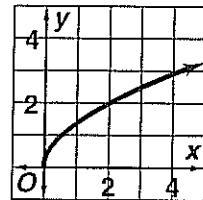
47. $y = \frac{\sqrt{x}}{2}$

x	y
0	0
1	$\frac{1}{2}$
4	1
9	$1\frac{1}{2}$



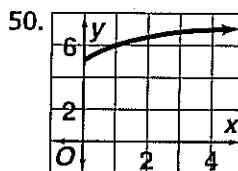
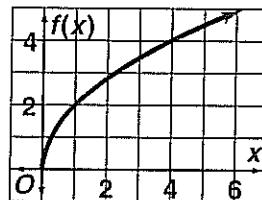
48. $y = \sqrt{2x}$

x	y
0	0
$\frac{1}{2}$	1
2	2
8	4

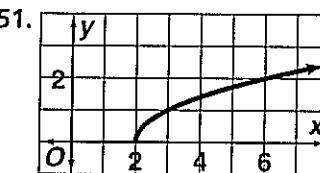


49. $f(x) = 2\sqrt{x}$

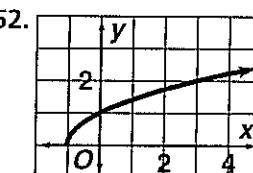
x	y
0	0
1	2
4	4



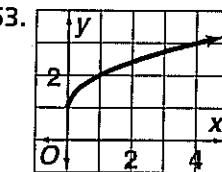
$y = \sqrt{x} + 5$; domain: $x \geq 0$;
translate $y = \sqrt{x}$, 5 units up



$y = \sqrt{x-2}$; domain:
 $x-2 \geq 0; x \geq 2$;
translate $y = \sqrt{x}$,
2 units right

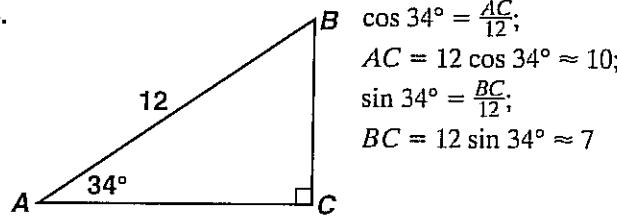


$y = \sqrt{x+1}$; domain:
 $x+1 \geq 0; x \geq -1$;
translate $y = \sqrt{x}$,
1 unit left

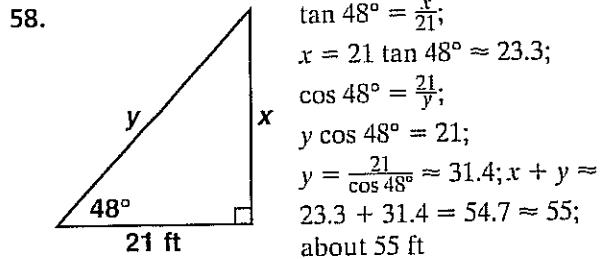
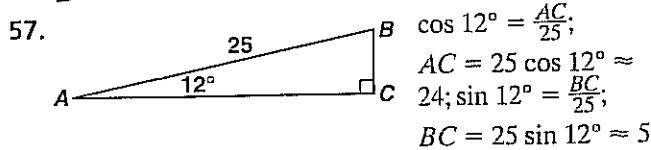
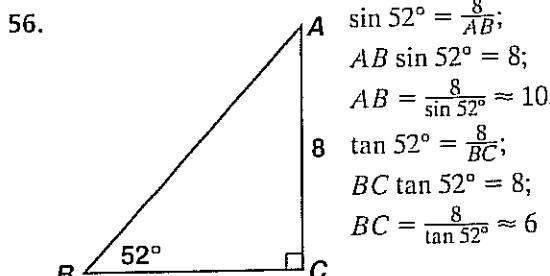
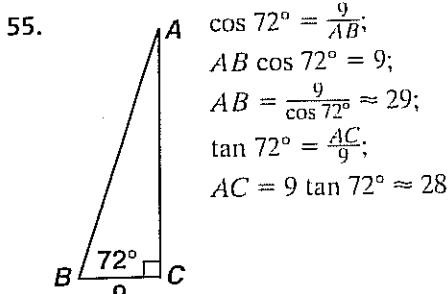


$y = 1 + \sqrt{x}$; domain:
 $x \geq 0$; translate $y = \sqrt{x}$,
1 unit up

54.



$B \cos 34^\circ = \frac{AC}{12}$;
 $AC = 12 \cos 34^\circ \approx 10$;
 $\sin 34^\circ = \frac{BC}{12}$;
 $BC = 12 \sin 34^\circ \approx 7$



CHAPTER TEST

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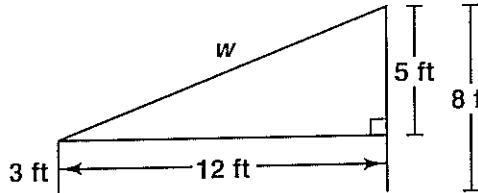
1. $6^2 + 8^2 = 10^2$; $36 + 64 = 100$; $100 = 100$; yes
2. $6^2 + 7^2 = 9^2$; $36 + 49 = 81$; $85 \neq 81$; no 3. $4^2 + 5^2 = 11^2$; $16 + 25 = 121$; $41 \neq 121$; no 4. $10^2 + 24^2 = 26^2$; $100 + 576 = 676$; $676 = 676$; yes 5. $40.9^2 + 40.9^2 = h^2$; $1672.81 + 1672.81 = h^2$; $3345.62 = h^2$; $h \approx 57.8$; about 57.8 cm 6. $AB = \sqrt{(5 - 1)^2 + (7 - (-2))^2} = \sqrt{4^2 + 9^2} = \sqrt{16 + 81} = \sqrt{97} \approx 9.8$ units 7. $AB = \sqrt{(7.2 - 3.1)^2 + (4.6 - 5)^2} = \sqrt{4.1^2 + (-0.4)^2} = \sqrt{16.81 + 0.16} = \sqrt{16.97} \approx 4.1$ units 8. $AB = \sqrt{(-11 - 4)^2 + (-6 - 7)^2} = \sqrt{(-15)^2 + (-13)^2} = \sqrt{225 + 169} = \sqrt{394} \approx 19.8$ units 9. $AB = \sqrt{(3 - 0)^2 + (2 - (-5))^2} = \sqrt{3^2 + 7^2} = \sqrt{9 + 49} = \sqrt{58} \approx 7.6$ units 10. midpoint = $\left(\frac{4+1}{2}, \frac{9+(-5)}{2}\right) = \left(\frac{5}{2}, \frac{4}{2}\right) = \left(2\frac{1}{2}, 2\right)$ 11. midpoint = $\left(\frac{-2+3}{2}, \frac{-7+0}{2}\right) = \left(\frac{1}{2}, \frac{-7}{2}\right) = \left(\frac{1}{2}, -3\frac{1}{2}\right)$ 12. midpoint = $\left(\frac{3+(-4)}{2}, \frac{-10+6}{2}\right) = \left(-\frac{1}{2}, -\frac{4}{2}\right) = \left(-\frac{1}{2}, -2\right)$

13. midpoint = $\left(\frac{0+(-1)}{2}, \frac{8\frac{1}{2}+1\frac{1}{2}}{2}\right) = \left(-\frac{1}{2}, \frac{10}{2}\right) = \left(-\frac{1}{2}, 5\right)$

14. $\sin 24^\circ = \frac{12}{AB}$; $AB \sin 24^\circ = 12$; $AB = \frac{12}{\sin 24^\circ} \approx 29.5$

15. $\tan 24^\circ = \frac{12}{AC}$; $AC \tan 24^\circ = 12$; $AC = \frac{12}{\tan 24^\circ} \approx 27.0$

16.



$5^2 + 12^2 = w^2$; $25 + 144 = w^2$; $169 = w^2$; $w = 13$; 13 ft

17. $12^2 + 9^2 = d^2$; $144 + 81 = d^2$; $225 = d^2$; $d = 15$; 15 mi

18. $\sqrt{\frac{128}{64}} = \sqrt{2}$ 19. $\sqrt{\frac{27}{75}} = \sqrt{\frac{9}{25}} = \frac{\sqrt{9}}{\sqrt{25}} = \frac{3}{5}$

20. $\sqrt{48} = \sqrt{16 \cdot 3} = \sqrt{16} \cdot \sqrt{3} = 4\sqrt{3}$

21. $\sqrt{12} \cdot \sqrt{8} = \sqrt{12 \cdot 8} = \sqrt{96} = \sqrt{16 \cdot 6} =$

$\sqrt{16} \cdot \sqrt{6} = 4\sqrt{6}$ 22. $3\sqrt{32} + 5\sqrt{2} =$

$3\sqrt{16 \cdot 2} + 5\sqrt{2} = 3(4)\sqrt{2} + 5\sqrt{2} = 12\sqrt{2} + 5\sqrt{2} =$

$(12 + 5)\sqrt{2} = 17\sqrt{2}$ 23. $2\sqrt{27} + 5\sqrt{3} =$

$2\sqrt{9 \cdot 3} + 5\sqrt{3} = 2(3)\sqrt{3} + 5\sqrt{3} = 6\sqrt{3} + 5\sqrt{3} =$

$(6 + 5)\sqrt{3} = 11\sqrt{3}$ 24. $7\sqrt{125} - 3\sqrt{175} =$

$7\sqrt{25 \cdot 5} - 3\sqrt{25 \cdot 7} = 7(5)\sqrt{5} - 3(5)\sqrt{7} =$

$35\sqrt{5} - 15\sqrt{7}$ 25. $\sqrt{128} - \sqrt{192} =$

$\sqrt{64 \cdot 2} - \sqrt{64 \cdot 3} = 8\sqrt{2} - 8\sqrt{3}$

26. $\frac{15}{\sqrt{3}} = \frac{15}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{15\sqrt{3}}{3} = 5\sqrt{3}$ 27. $\frac{8}{\sqrt{10} + \sqrt{6}} =$

$\frac{8}{\sqrt{10} + \sqrt{6}} \cdot \frac{\sqrt{10} - \sqrt{6}}{\sqrt{10} - \sqrt{6}} = \frac{8(\sqrt{10} - \sqrt{6})}{10 - 6} =$

$\frac{8(\sqrt{10} - \sqrt{6})}{4} = 2(\sqrt{10} - \sqrt{6})$ 28. Answers may vary.

Sample: $2\sqrt{5} + 4\sqrt{5} = 6\sqrt{5}$ 29. $\sqrt{24x^2y^3} =$

$\sqrt{4x^2y^2 \cdot 6y} = 2xy\sqrt{6y}$; B 30. $3\sqrt{x} + 2\sqrt{x} = 10$;

$5\sqrt{x} = 10$; $\sqrt{x} = 2$; $(\sqrt{x})^2 = 2^2$; $x = 4$

31. $8 = \sqrt{5x - 1}$; $8^2 = (\sqrt{5x - 1})^2$; $64 = 5x - 1$; $5x =$

65 ; $x = 13$ 32. $5\sqrt{x} = \sqrt{15x + 60}$; $(5\sqrt{x})^2 =$

$(\sqrt{15x + 60})^2$; $25x = 15x + 60$; $10x = 60$; $x = 6$

33. $\sqrt{x} = \sqrt{2x - 7}$; $(\sqrt{x})^2 = (\sqrt{2x - 7})^2$;

$x = 2x - 7$; $-x = -7$; $x = 7$ 34. $3\sqrt{x+3} = 2\sqrt{x+9}$;

$(3\sqrt{x+3})^2 = (2\sqrt{x+9})^2$; $9(x+3) = 4(x+9)$;

$9x + 27 = 4x + 36$; $5x = 9$; $x = \frac{9}{5}$ 35. $\sqrt{3x} = x - 5$;

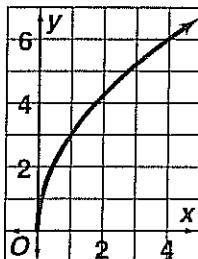
$(\sqrt{3x})^2 = (x - 5)^2$; $3x = x^2 - 10x + 25$;

$x^2 - 13x + 25 = 0$; $x = \frac{-(-13) \pm \sqrt{(-13)^2 - 4(1)(25)}}{2(1)} =$

$\frac{13 \pm \sqrt{69}}{2}$; $x = \frac{13 + \sqrt{69}}{2} \approx 10.65$ or $x = \frac{13 - \sqrt{69}}{2} \approx 2.35$

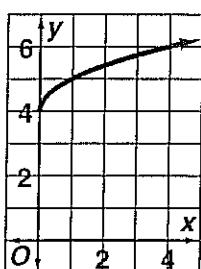
(extraneous); ≈ 10.65 36. $100 = w \cdot 5w$; $5w^2 = 100$; $w^2 = 20$; $w = \sqrt{20} = \sqrt{4 \cdot 5} = 2\sqrt{5}$; $2\sqrt{5}$ ft

37.



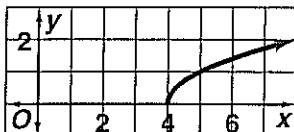
$$y = 3\sqrt{x}; \text{ domain: } x \geq 0$$

38.



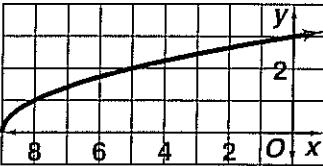
$$y = \sqrt{x} + 4; \text{ domain: } x \geq 0$$

39.



$$y = \sqrt{x - 4}; \\ \text{domain: } x - 4 \geq 0; \\ x \geq 4$$

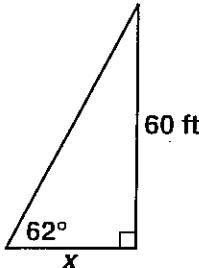
40.



$$y = \sqrt{x + 9}; \\ \text{domain: } x + 9 \geq 0; \\ x \geq -9$$

41. $10^2 + x^2 = 26^2; 100 + x^2 = 676; x^2 = 576; \sqrt{x^2} = \sqrt{576}; x = 24; 24 \text{ cm}$ 42. For the graph of $y = \sqrt{x} - 3$, the graph of $y = \sqrt{x}$ is translated 3 units down.

43. $V = \pi r^2 h; \frac{V}{\pi h} = r^2; \sqrt{\frac{V}{\pi h}} = \sqrt{r^2}; r = \sqrt{\frac{V}{\pi h}}$
 $\tan 62^\circ = \frac{60}{x}; x \tan 62^\circ = 60;$
 $x = \frac{60}{\tan 62^\circ} \approx 32; \text{ about 32 ft}$

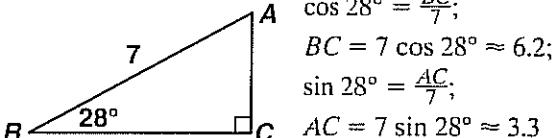


45. $\tan 42^\circ = \frac{RT}{9}; RT = 9 \tan 42^\circ \approx 8.1$ 46. $\cos 42^\circ = \frac{9}{ST}; ST \cos 42^\circ = 9; ST = \frac{9}{\cos 42^\circ} \approx 12.1$ 47. $\tan 42^\circ = \frac{RT}{9};$

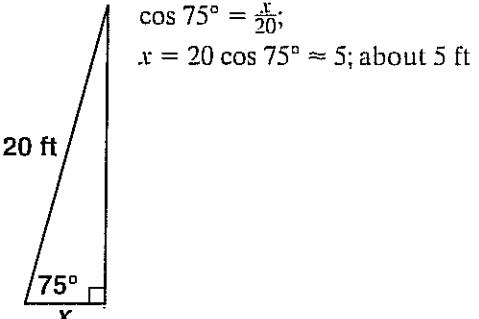
$$RT = 9 \tan 42^\circ \approx 8.1; \tan T = \frac{RS}{RT} \approx \frac{9}{8.1} \approx 1.1$$

$$48. \cos 42^\circ = \frac{9}{ST}; ST \cos 42^\circ = 9; ST = \frac{9}{\cos 42^\circ} \approx 12.1; \\ \sin T = \frac{RS}{ST} \approx \frac{9}{12.1} \approx 0.74$$

49.



50.



STANDARDIZED TEST PREP

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1. $18(2500) = \$45,000$; B 2. $40(1000) = \$40,000$; H
 3. sales: $1000 - 50 = 950$; revenue: $\$45(950) = \$42,750$; D 4. quadratic; G 5. $s = 1000 - 50n$, $p = 40 + 5n$; D 6. [2] 6a. $\frac{-b}{2a}$ is the maximum, so $\frac{-3000}{2(-250)} = 6$; they can increase the price by a factor of six.

- 6b. $r = 40,000 + 3000(6) - 250(6)^2 = 49,000$; the maximum revenue is \$49,000. 6c. $1000 - 50(6) = 1000 - 300 = 700$; the maximum number of sales is 700. 6d. $40 + 5(6) = 40 + 30 = 70$; Carlos and Anna should charge \$70 per game. [1] appropriate methods, but one computational error 7. [2] The table shows what happens as the price decreases.

Price	Number Sold	Revenue
\$40	1000	\$40,000
\$35	1050	\$36,750
\$30	1100	\$33,000

The decrease in price does not result in an increase in revenue. So Carlos and Anna should not decrease the price OR equivalent explanation. [1] correct conclusion but insufficient explanation.