

Answers to Warm Ups, Odd-Numbered Exercises, Quizzes, and Tests

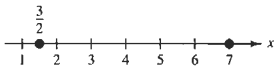
Chapter R1

Section R1.1 (page R8)

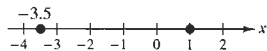
1. (a) Natural: $\{5\}$
 (b) Integer: $\{-9, 5\}$
 (c) Rational: $\{-9, -\frac{7}{2}, 5, \frac{2}{3}, 0.1\}$
 (d) Irrational: $\{\sqrt{2}\}$
3. (a) Natural: $\{12, 1, \sqrt{4}\}$ (Note: $\sqrt{4} = 2$)
 (b) Integer: $\{12, -13, 1, \sqrt{4}\}$
 (c) Rational: $\{12, -13, 1, \sqrt{4}, \frac{3}{2}\}$
 (d) Irrational: $\{\sqrt{6}\}$
5. (a) Natural: $\{\frac{8}{2}, 9\}$ (Note: $\frac{8}{2} = 4$)
 (b) Integer: $\{\frac{8}{2}, -4, 9\}$
 (c) Rational: $\{\frac{8}{2}, -\frac{8}{3}, -4, 9, 14.2\}$
 (d) Irrational: $\{\sqrt{10}\}$

7. 0.625 9. $0.5\bar{4}$ 11. $-1 < 2.5$

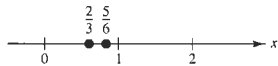
13. $\frac{3}{2} < 7$



15. $-3.5 < 1$

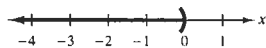


17. $\frac{5}{6} > \frac{2}{3}$

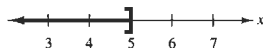


19. $\frac{127}{90}, \frac{584}{413}, \frac{7071}{5000}, \sqrt{2}, \frac{47}{33}$

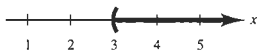
21. $x < 0$ denotes all negative real numbers.



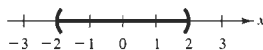
23. $x \leq 5$ denotes all real numbers less than or equal to 5.



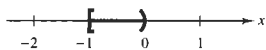
25. $x > 3$ denotes all real numbers greater than 3.



27. $-2 < x < 2$ denotes all real numbers greater than -2 and less than 2.



29. $-1 \leq x < 0$ denotes all real numbers greater than or equal to -1 and less than 0.



31. $x < 0$ 33. $A \geq 35$ years 35. $3.5\% \leq r \leq 6\%$

37. 10 39. -6 41. -9 43. -1 45. $\pi - 3$

47. $|-7| = |7|$ 49. $|-3| > -|-3|$

51. $-|-2| = -|2|$ 53. 4 55. $\frac{5}{2}$ 57. $\frac{7}{2}$

59. 51 61. $\frac{128}{75}$ 63. $|z - \frac{3}{2}| > 1$

65. $|x + 10| \geq 6$ 67. $|y - 0| \geq 6 \implies |y| \geq 6$

69. 179 miles 71. 37°

		<i>Passes Budget</i>
	$ a - b $	0.05b
		<i>Variance Test</i>
73.	\$127.88	\$1250 Yes
75.	\$572.59	\$470 No
77.	\$671.75	\$1882 No

		<i>Passes Quality</i>
	$ a - b $	0.002b
		<i>Control Test</i>
79.	0.02	0.03 Yes
81.	0.045	0.033 No
83.	0.035	0.036 No

85. (a) No. If $u > 0$ and $v < 0$ or $u < 0$ and $v > 0$, then $|u + v| \neq |u| + |v|$.

(b) Yes. If the signs of u and v are different, then $|u + v| < |u| + |v|$.

87. Answers will vary. Example: The set of natural numbers includes only the integers greater than zero. The set of integers include all numbers that have no fractional or decimal parts. The set of rational numbers includes all numbers that can be written as the quotient of two integers. Any real number that is not a rational number is in the set of irrational numbers.

Section R1.2 (page R18)

Warm Up (page R18)

1. $-4 < -2$ 2. $0 > -3$ 3. $\sqrt{3} > 1.73$
4. $-\pi < -3$ 5. $|6 - 4| = 2$ 6. $|2 - (-2)| = 4$
7. $|0 - (-5)| = 5$ 8. $|3 - (-1)| = 4$
9. $|-7| + |7| = 7 + 7 = 14$
10. $-|8 - 10| = -|-2| = -2$

1. $7x, 4$ 3. $x^2, -4x, 8$ 5. $2x^2, -9x, 13$ 7. -6

9. 6 11. (a) -10 (b) -6 13. (a) 14 (b) 2

15. (a) 0 (b) 0

17. (a) Undefined. You cannot divide by zero. (b) $\frac{1}{2}$

19. Commutative (addition) 21. Inverse (addition)

A30 **Answers to Warm Ups, Odd-Numbered Exercises, Quizzes, and Tests**

23. Distributive Property 25. Inverse (multiplication)
 27. Identity (addition) 29. Identity (multiplication)
 31. Associative (addition)
 33. $x(3y) = (x \cdot 3)y$ Associative (multiplication)
 $= (3x)y$ Commutative (multiplication)
 35. $2^2 \cdot 3^2$ 37. $2^3 \cdot 5^2$ 39. -14 41. $\frac{1}{24}$
 43. $\frac{7}{20}$ 45. $\frac{1}{12}$ 47. -0.13 49. 1.56 51. 18.81
 53. 41.14 55. 16.6% 57. ≈ 2 meals
 59. (a) 34.6%
 (b) Social Security: \approx \$456 billion
 Veteran's Benefits: \approx \$51 billion
 Education: \approx \$71 billion
 Health: \approx \$196 billion
 Medicare: \approx \$231 billion
 Income Security: \approx \$312 billion
 (c) \approx \$260 billion; Answers will vary. Example: No. Because the total human resources expenses will change, the amounts of money spent on Social Security and healthcare will change, and so the difference between these amounts will change.

61. ≈ 5237 students
 63. (a) Scientific: 5 \times () 18 () 2 y^x 3 ()
 () \div 10 ()
 Graphing: 5 \times () 18 () 2 () \wedge 3 ()
 () \div 10 () ENTER
 (b) Scientific: 6 \times () \pm () 7 () \pm () 2 () \pm ()
 () y^x 3 () ()
 Graphing: () 6 \times () () 7 () \pm () () 2 () () \wedge
 3 () ENTER

Section R1.3 (page R27)

Warm Up (page R27)

1. 1 2. 5 3. 4 4. 4 5. $\frac{1}{4}$ 6. 1
 7. $\frac{3}{7}$ 8. 0 9. $-\frac{1}{8}$ 10. 1

1. 64 3. 8 5. 729 7. -81 9. $\frac{1}{2}$ 11. 8
 13. $-\frac{3}{10}$ 15. 5184 17. $-\frac{3}{5}$ 19. 1 21. 18
 23. $\frac{7}{16}$ 25. $-125z^3$ 27. $16x^7$ 29. $10x^4$
 31. $-3z^7$ 33. $\frac{5y^4}{2}$ 35. $\frac{5184}{y^7}$ 37. $\frac{7}{x}$ 39. $\frac{1}{x}$
 41. 3^{3n} 43. $1, x \neq 0$ 45. $\frac{1}{(y+2)^3}$ 47. $32y^2$

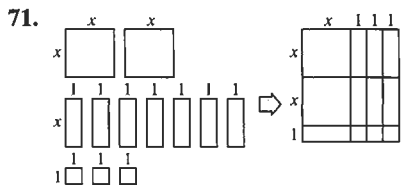
49. $\frac{10}{x}$ 51. $\frac{125x^9}{y^{12}}$ 53. 5.73×10^7 square miles
 55. 9.461×10^{12} kilometers 57. 350,000,000 air sacs
 59. 0.0000000000000000001602 coulomb
 61. 1×10^{18} attoseconds
 63. (a) 6.0×10^4 (b) 2.0×10^{11}
 65. (a) 3.071×10^6 (b) 3.077×10^{10}
 67. (a) 4.907×10^{17} (b) 1.479
 69. (a) $(5.1 - 3.6)^5$ (b) $[1 + 3(2)]^{-2}$
 71. (a) \$19,154.30 (b) \$19,147.63
 (c) \$19,121.84 (d) \$19,055.59
 As the number of compoundings per year increases, the balance in the account also increases.
 73. $\approx 4.46\%$

Section R1.4 (page R36)

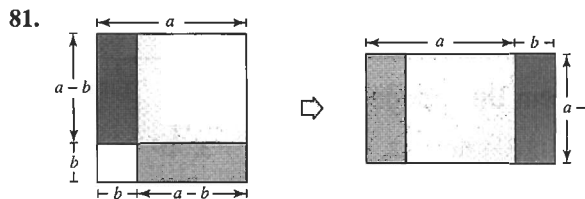
Warm Up (page R36)

1. $\frac{4}{27}$ 2. 48 3. $-8x^3$ 4. $6x^7$
 5. $28x^6$ 6. $\frac{1}{5}x^2$ 7. $3z^4$ 8. $\frac{25}{4x^2}$ 9. 1
 10. $(x + 2)^{10}$

1. $9^{1/2} = 3$ 3. $\sqrt[5]{32} = 2$ 5. $\sqrt{196} = 14$
 7. $(-216)^{1/3} = -6$ 9. $81^{3/4} = 27$ 11. $\sqrt[3]{27^2} = 9$
 13. 3 15. 3 17. $\frac{1}{2}$ 19. -125 21. 4
 23. 216 25. $\sqrt{6}$ 27. $\frac{27}{8}$ 29. -4
 31. $2x\sqrt[3]{2x^2}$ 33. $\frac{5|x|\sqrt{3}}{y^2}$ 35. $\frac{2\sqrt[3]{2}}{y}$ 37. $\frac{\sqrt{3}}{3}$
 39. $4\sqrt[3]{4}$ 41. $\frac{x(5 + \sqrt{3})}{11}$ 43. $3(\sqrt{6} - \sqrt{5})$
 45. 25 47. $2^{1/2}$ 49. $x^{3/2}, x \neq 0$ 51. $2\sqrt[4]{2}$
 53. $3^{1/2} = \sqrt{3}$ 55. $\sqrt[3]{x}$ 57. $2\sqrt{x}$
 59. $31\sqrt{2}$ 61. $-2\sqrt{y}$ 63. 3.557 65. 2.006
 67. 2.938 69. 0.382 71. $\sqrt{5} + \sqrt{3} > \sqrt{5+3}$
 73. $5 > \sqrt{3^2 + 2^2}$ 75. $\sqrt{3} \cdot \sqrt[4]{3} > \sqrt[8]{3}$
 77. 24 inches \times 24 inches \times 24 inches 79. $\approx 12.8\%$
 81. No. The escape velocity is equal to approximately 2375 meters per second, which is greater than the velocity of the rocket.
 83. ≈ 1.57 seconds 85. ≈ 0.026 inch
 87. ≈ 494 vibrations per second



73. $(2x + 1)$ feet
 75. (a) $(x - 2)(3x + 4)$ (b) $(x + 5)(x + 6)$
 77. $c = \{9, 16, 21, 24, 25\}$; Answers will vary.
 79. Answers will vary.



Section R1.7 (page R60)

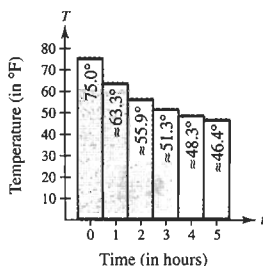
Warm Up (page R60)

1. $5x^2(1 - 3x)$ 2. $(4x + 3)(4x - 3)$
 3. $(3x - 1)^2$ 4. $(2y + 3)^2$ 5. $(z + 3)(z + 1)$
 6. $(x - 5)(x - 10)$ 7. $(3 - x)(1 + 3x)$
 8. $(3x - 1)(x - 15)$ 9. $(s + 1)(s + 2)(s - 2)$
 10. $(y + 4)(y^2 - 4y + 16)$

1. All real numbers 3. All real numbers except $x = 2$
 5. All real numbers except $x = 0$ and $x = 4$
 7. All real numbers greater than or equal to -1
 9. $3x$ 11. $x - 2, x \neq 2$ 13. $x + 2, x \neq -2$
 15. $\frac{3x}{2}, x \neq 0$ 17. $\frac{x}{2(x + 1)}$ 19. $-\frac{1}{2}, x \neq 5$
 21. $-(x + 5), x \neq 5$ 23. $\frac{x(x + 3)}{x - 2}, x \neq -2$
 25. $\frac{y - 4}{y + 6}, y \neq 3$ 27. $-1 - x^2, x \neq 2$ 29. $z - 2$
 31. $\frac{1}{5(x - 2)}, x \neq 1$ 33. $-\frac{x(x + 7)}{x + 1}, x \neq 9$
 35. $\frac{r + 1}{r}, r \neq 1$ 37. $\frac{t - 3}{(t + 3)(t - 2)}, t \neq -2$
 39. $\frac{x - 1}{x(x + 1)^2}, x \neq -2$ 41. $\frac{3}{2}, x \neq -y$
 43. $x(x + 1), x \neq -1, 0$ 45. $\frac{x + 5}{x - 1}$ 47. $\frac{2x + 5}{x - 5}$

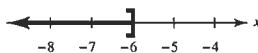
49. $\frac{6x + 13}{x + 3}$ 51. $\frac{x - 4}{(x + 2)(x - 2)(x - 1)}$
 53. $\frac{2 - x}{x^2 + 1}, x \neq 0$ 55. $\frac{1}{2}, x \neq 2$ 57. $\frac{1}{x}, x \neq -1$
 59. $\frac{2x - 1}{2x}, x > 0$ 61. (a) 12.65% (b) $\frac{288(NM - P)}{N(12P + NM)}$

63. ; No



Review Exercises (page R64)

1. (a) Natural: $\{11\}$
 (b) Integer: $\{11, -14\}$
 (c) Rational: $\{11, -14, -\frac{8}{9}, \frac{5}{2}, 0.4\}$
 (d) Irrational: $\{\sqrt{6}\}$
 3. $-4 < -3$
 5. $x \leq -6$ denotes all real numbers less than or equal to -6 .



7. $x \geq 0$ 9. -14 11. $|-12| > -|12|$ 13. 3
 15. $|x - 7| \geq 4$ 17. $2x^2, -3x, 4$ 19. (a) 2 (b) 0
 21. Distributive Property 23. -1 25. $\frac{2}{3}$ 27. 5
 29. 0.10 31. -2 33. $8x$ 35. 3.5116×10^7
 37. 483,400,000 miles
 39. (a) 11,414.125 (b) 18,380.160

41.

Year	5	10	15
Balance	\$2697.70	\$3638.79	\$4908.19

Year	20	25
Balance	\$6620.41	\$8929.94

43. $16^{1/2} = 4$ 45. 13 47. $2x^2$ 49. $2 + \sqrt{3}$
 51. $-3\sqrt{x}$ 53. $\sqrt{10}$ 55. $\sqrt{5}$ 57. 11.269
 59. $-6x + 26$ 61. $x^2 - 8x - 14$ 63. $x^2 - x - 2$
 65. $x^3 - x^2 + 2x - 2$

67. 260.74

In 2002, the median sales price for a new one-family home in the northeastern United States was \$260,740.

69. $x = 5$: 27,132.5

$x = 12$: 139,620.4

There were 27,132,500 and 139,620,400 cell phone subscribers in the United States in 1995 and 2002, respectively.

71. $4(x + 3)(x - 3)$ 73. $3x(x + 1)(x - 2)$

75. $(x^2 - 2)(x - 4)$ 77. All real numbers except $x = 3$

79. All real numbers 81. $3x$

83. $\frac{x - 2}{2}, x \neq -2$ 85. $x + 2, x \neq 0$

87. $\frac{x - 1}{x - 3}, x \neq -1, \frac{1}{2}$ 89. $\frac{3x^2 - 4x}{(x - 1)(x - 2)}$

91. $\frac{x + 1}{x - 1}, x \neq 0$ 93. $\frac{4x}{2x - 3}, x \neq 0, -\frac{3}{2}$

Chapter Test (page R67)

1. -12

2.

Year	5	10	15
Balance	\$4470	\$6659	\$9921

Year	20	25
Balance	\$14,780	\$22,021

The longer you leave the \$3000 in the account, the more money you earn.

3. $-64x^6$ 4. $-4\sqrt{x}$ 5. 25 6. $4(\sqrt{3} - \sqrt{5})$

7. $2x\sqrt{3x}$ 8. $\frac{5 + \sqrt{7}}{9}$ 9. $9x^2 + 42x + 49$

10. $-5x^2 + 29x$ 11. $5(x + 4)(x - 4)$

12. $(2x + 3)^2$ 13. $(x^2 - 3)(x - 6)$

14. $(x + 2)^2(x - 2)$ 15. $\frac{1}{3}(x - 4), x \neq -4$

16. $\frac{x + 4}{3x + 5}, x \neq -3, \frac{5}{3}$ 17. $\frac{4x^2 - 13x}{(x - 3)(x - 4)}$

18. $-\frac{x + 26}{(x + 5)(x - 2)}$

19. All real numbers greater than or equal to -3

20. All real numbers except $x = 2$

21. $\frac{2x^2 - 5x - 18}{5 + 5x - x^2}, x \neq 1, -2$

22. $x = 5$: 236.75, $x = 12$: 294.36

In 1995 and 2002, the total expenditures for U.S. colleges and universities were about \$236.75 billion and \$294.36 billion, respectively.

Chapter R2

Section R2.1 (page R76)

Warm Up (page R76)

1. $-3x - 10$ 2. $5x - 12$ 3. x 4. $x + 26$

5. $\frac{8x}{15}$ 6. $\frac{3x}{4}$ 7. $-\frac{1}{x(x + 1)}$ 8. $\frac{5}{x}$

9. $\frac{7x - 8}{x(x - 2)}$ 10. $-\frac{2}{x^2 - 1}$

1. Identity 3. Conditional equation

5. Conditional equation

7. (a) No (b) No (c) Yes (d) No

9. (a) Yes (b) Yes (c) No (d) No

11. (a) Yes (b) No (c) No (d) No

13. (a) No (b) No (c) No (d) Yes

15. (a) No (b) No (c) No (d) No

17. 5 19. -4 21. 3 23. 9 25. -26

27. -4 29. $-\frac{6}{5}$ 31. 9 33. No solution

35. 10 37. 4 39. 3 41. 5 43. No solution

45. $\frac{11}{6}$ 47. No solution 49. 0

51. All real numbers 53. No solution

55. Because substituting 2 for x in the equation produces division by zero, $x = 2$ cannot be a solution to the equation.

57. Check by substituting in the original equation, by using the *table* feature of a graphing utility, or by evaluating the solution in the original equation using a graphing utility.

59. $x \approx 138.889$ 61. $x \approx 62.372$ 63. $x \approx 19.993$

65. Use the *table* feature in ASK mode or use the scientific calculator part of the graphing utility.

67. (a) 6.46 (b) 6.41; Yes

69. (a) 56.09 (b) 56.13; Yes

71. 2004 ($t \approx 14.02$) 73. 61.2 inches

75. 1998 ($t \approx 8.35$) 77. 1999 ($t \approx 9.29$)

Section R2.2 (page R87)

Warm Up (page R87)

1. 14 2. 4 3. -3 4. 4 5. -2

6. 1 7. $\frac{2}{5}$ 8. $\frac{10}{3}$ 9. 6 10. $-\frac{11}{5}$

1. $x + (x + 1) = 2x + 1$ 3. $50t$ 5. $0.2x$ 7. $6x$

9. $1200 + 25x$ 11. $525 = n + (n + 1)$; 262, 263

13. $5x - x = 148$; 37, 185

15. $n^2 - 5 = n(n + 1)$; $-5, -4$

17. Coworker's check: \$300

Your check: \$345

19. Coworker's check: \$348.65

Your check: \$296.35

21. $\approx 37.03\%$ decrease 23. $\approx 39.42\%$ increase

25. (a) ≈ 498.96 million users

(b) ≈ 543.87 million users

(c) ≈ 580.85 million users

27. Two TVs: ≈ 36.278 million households

Three or more TVs: ≈ 43.747 million households

VCR: ≈ 97.097 million households

Basic cable: ≈ 74.690 million households

Premium cable: ≈ 51.216 million households

29. 15 feet \times 22.5 feet 31. ≈ 5.7 years

33. 97 or greater 35. \$22,316.98

37. \$1411.76 39. $\approx 20.13\%$ 41. \$361.25

43. 3 hours 45. $\frac{1}{3}$ hour

47. Family 1 (42 miles per hour): ≈ 3.8 hours

Family 2 (50 miles per hour): 3.2 hours

49. ≈ 1.28 seconds 51. 62.5 feet 53. \$563,952

55. \$4500 at 5.5% 57. 11.43%
\$7500 at 7%

59. 8823 units per month 61. ≈ 48 feet

63. ≈ 32.1 gallons 65. ≈ 12.31 miles per hour

67. $h = \frac{2A}{b}$ 69. $l = \frac{V}{wh}$ 71. $C = \frac{S}{1 + R}$

73. $r = \frac{A - P}{Pt}$ 75. $b = \frac{2A - ah}{h}$

77. $n = \frac{L + d - a}{d}$ 79. $h = \frac{A}{2\pi r}$

81. A mathematical model should be accurate and easy to use. If the model is very complicated, the user may make errors or choose not to use the model. So, sometimes a reasonably accurate model that is easy to use is better than a very complicated model that is more accurate.

83. ≈ 192.27 cubic inches

Section R2.3 (page R100)

Warm Up (page R100)

1. $\frac{\sqrt{14}}{10}$ 2. $4\sqrt{2}$ 3. 14 4. $\frac{\sqrt{10}}{4}$

5. $x(3x + 7)$ 6. $(2x - 5)(2x + 5)$

7. $-(x - 7)(x - 15)$ 8. $(x - 2)(x + 9)$

9. $(5x - 1)(2x + 3)$ 10. $(6x - 1)(x - 12)$

1. $2x^2 + 5x - 3 = 0$ 3. $x^2 - 25x = 0$

5. $x^2 - 6x + 7 = 0$ 7. $2x^2 - 2x + 1 = 0$

9. $3x^2 - 60x - 10 = 0$ 11. 4, -2 13. 0, $-\frac{1}{2}$

15. -5 17. 3, $-\frac{1}{2}$ 19. 2, -6 21. $-2, -5$

23. ± 4 25. $\pm\sqrt{7} \approx \pm 2.65$ 27. $\pm 2\sqrt{3} \approx \pm 3.46$

29. $12 + 3\sqrt{2} \approx 16.24$ 31. $-2 + 2\sqrt{3} \approx 1.46$

$12 - 3\sqrt{2} \approx 7.76$ $-2 - 2\sqrt{3} \approx -5.46$

33. ± 5 35. $\pm\frac{\sqrt{115}}{5} \approx \pm 2.14$ 37. ± 8 39. 1

41. $\pm\frac{3}{4}$ 43. $\frac{3}{2}$ 45. 6, -12 47. $\frac{3}{2}, -\frac{1}{2}$ 49. 5, $-\frac{10}{3}$

51. 9, 3 53. $\frac{1}{5}, 1$ 55. $-1, -5$ 57. $-\frac{1}{2}$

59. Algebra argument:

$(x + 2)^2 = (x + 2)(x + 2)$ Definition of exponent

$= x^2 + 2x + 2x + 4$ FOIL

$= x^2 + 4x + 4$ Combine like terms.

So, $(x + 2)^2 \neq x^2 + 4$.

Graphing utility argument:

(1) Let $y_1 = (x + 2)^2$ and $y_2 = x^2 + 4$. Use the *table* feature with an arbitrary value of x (but not $x = 0$). The table will show that y_1 is not the same as y_2 .

(2) Use the scientific calculator portion of the graphing utility to show that if $x = 5$, $(5 + 2)^2 = 49$ and $5^2 + 4 = 29$. So, $(x + 2)^2$ is not equal to $x^2 + 4$.

61. 34 feet \times 48 feet

63. Base: $2\sqrt{2}$ feet
Height: $2\sqrt{2}$ feet

65. ≈ 3.54 seconds 67. ≈ 1.43 seconds

69. ≈ 24.37 seconds 71. ≈ 3.54 centimeters

73. 976 miles 75. ≈ 1414 feet

77. 50,000 units 79. 2015 ($t \approx 15.4$)

81. 1987 ($t \approx 18.74$); The model is a good representation through 2002.

83. The model in Exercise 82 is *not* valid for the population in 2050 because it predicts 536,526,000 people (not 419,854,000).
85. 2002 ($t \approx 11.62$); No; for 1980 ($t = -10$) the model yields a value of $E = 865$, or 865,000 students. From 1995–2001, the enrollment steadily increased from 708,000 to 897,970 students. It is unlikely that in 1980 the enrollment was significantly higher than it was 15 years later in 1995.

Section R2.4 (page R110)

Warm Up (page R110)

1. $3\sqrt{17}$ 2. $2\sqrt{3}$ 3. $4\sqrt{6}$ 4. $3\sqrt{73}$
 5. 2, -1 6. $\frac{3}{2}, -3$ 7. 5, -1 8. $\frac{1}{2}, -7$
 9. 3, 2 10. 4, -1

1. One real solution 3. Two real solutions
 5. No real solutions 7. Two real solutions
 9. $\frac{1}{2}, -1$ 11. $\frac{1}{4}, -\frac{3}{4}$ 13. $1 \pm \sqrt{3}$
 15. $-7 \pm \sqrt{5}$ 17. $-4 \pm 2\sqrt{5}$ 19. $\frac{2}{3} \pm \frac{\sqrt{7}}{3}$
 21. $-\frac{1}{3} \pm \frac{\sqrt{11}}{6}$ 23. $-\frac{1}{2} \pm \sqrt{2}$ 25. $\frac{2}{7}$
 27. $2 \pm \frac{\sqrt{6}}{2}$ 29. $6 \pm \sqrt{11}$ 31. $x \approx 0.976, -0.643$
 33. $x \approx 0.561, 0.126$ 35. $x \approx 1.687, -0.488$
 37. -11 39. $\pm\sqrt{10}$ 41. $-\frac{3}{2} \pm \frac{\sqrt{5}}{2}$ 43. -2, 4
 45. ± 2 47. 50, 50 49. 7, 8 or -8, -7
 51. 200 units 53. 653 units 55. 9 seats per row
 57. 14 inches \times 14 inches
 59. Moon: ≈ 14.9 seconds
 Earth: ≈ 2.6 seconds
 61. Shorter period of time on Earth
 63. ≈ 259 miles; ≈ 541 miles
 65. (a) 1999 ($t \approx 9.28$)
 (b) 2005 ($t \approx 14.85$)
 (c) No. The model's prediction of \$899.66 exceeds the expected consumer spending.
 67. 2010 ($t = 10$); Yes. The model in Exercise 66 predicts a spending amount of \$378 billion, which is close to the industry's projection of \$374 billion.
 69. Southbound: ≈ 550 miles per hour
 Eastbound: ≈ 600 miles per hour

71. 3761 units or 146,239 units
 73. In an application, one of the solutions may not make sense in the context. In Example 5, the other possible solution is $t \approx -29.77$. Because the number of alternative fuel vehicles has been steadily growing since 1993, it is not likely that there were 1,000,000 of them in 1960. So, this solution ($t \approx -29.77$) can be rejected.

Mid-Chapter Quiz (page R114)

1. $x = -6$ 2. $x = 6$ 3. $x = -2$ 4. No solution
 5. 328.954 6. 431.398
 7. Use the table feature in ASK mode or the scientific calculator portion of the graphing utility.
 8. $7.50x + 20,000 = 80,000$; 8000 units
 9. 3499 units ($x \approx 3499.214$) or 321,501 units ($x \approx 321,500.786$)
 10. $x = \frac{2}{3}, -5$ 11. $x = \pm\sqrt{5}; x \approx \pm 2.24$
 12. $x = -3 \pm \sqrt{17}; x \approx -7.12, 1.12$
 13. $x = -1 \pm \sqrt{6}$ 14. $x = \frac{-7 \pm \sqrt{73}}{6}$
 15. $x \approx 1.568, -0.068$ 16. No real solutions
 17. One real solution
 18. Answers will vary. Sample answer: Use the FOIL method $[(x + 3)^2 = (x + 3)(x + 3) = x^2 + 6x + 9]$, use the *table* feature of your graphing utility, or use the scientific calculator portion of your graphing utility to evaluate the solution.
 19. ≈ 3.95 seconds 20. 6 inches \times 6 inches

Section R2.5 (page R123)

Warm Up (page R123)

1. 11 2. 20, -3 3. 5, -45 4. $0, -\frac{1}{5}$
 5. $\frac{2}{3}, -2$ 6. $\frac{11}{6}, -\frac{5}{2}$ 7. 1, -5 8. $\frac{3}{2}, -\frac{5}{2}$
 9. $\frac{3 \pm \sqrt{5}}{2}$ 10. $2 \pm \sqrt{2}$

1. 3, -1, 0 3. $0, \pm\frac{3\sqrt{2}}{2}$ 5. ± 3 7. -3, 0
 9. $\pm 2, 7$ 11. ± 1 13. $\pm\sqrt{11}, \pm 1$ 15. ± 2
 17. $\pm\frac{1}{2}, \pm 4$ 19. 1, -2 21. 50 23. 26
 25. -16 27. $\frac{1}{4}$ 29. 6, 5 31. 2, -5 33. 0
 35. -59, 69 37. 1 39. $\pm\sqrt{69}$ 41. $\frac{-3 \pm \sqrt{21}}{6}$
 43. 4, -5 45. -1 47. 1, -3 49. 1, -3

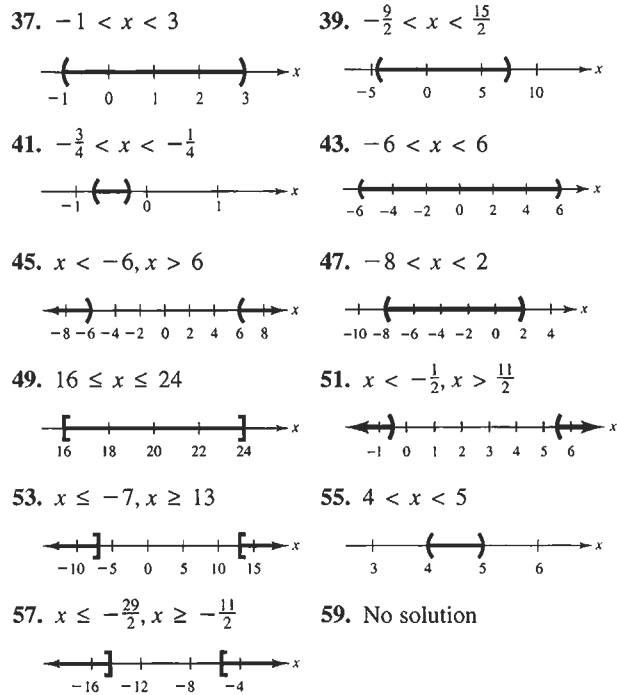
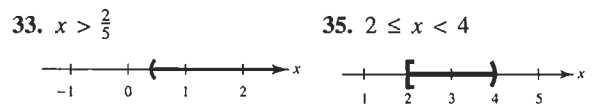
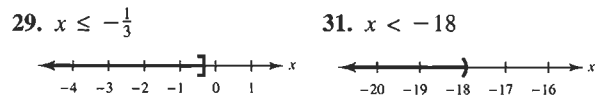
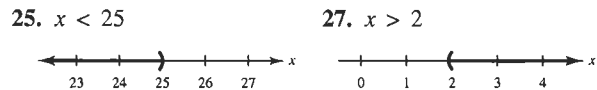
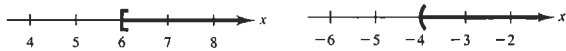
51. 3, -2 53. $\sqrt{3}$, -3 55. 10, -1
57. The quadratic equation was not written in standard form before the values for a , b , and c were substituted in the Quadratic Formula. The standard form for this equation is $3x^2 - 7x - 4 = 0$ ($a = 3$, $b = -7$, and $c = -4$), and the correct solution is
- $$x = \frac{-(-7) \pm \sqrt{(-7)^2 - 4(3)(-4)}}{2(3)}$$
59. $x \approx \pm 1.038$ 61. $x \approx 16.756$ 63. 34 65. 7%
67. $\approx 19.2\%$ 69. 26,250 passengers
71. 62 years old; This model is not used for people over the age of 65 because, as x increases past $x = 65$, the y -values are not low enough to produce realistic life expectancies.
73. 2,566,025 units; It does not make sense for demand x or price p to be less than zero.
75. ≈ 12.12 feet 77. $13\frac{1}{3}$ minutes 79. $11\frac{1}{9}$ hours

Section R2.6 (page R134)

Warm Up (page R134)

1. $-\frac{1}{2}$ 2. $-\frac{1}{6}$ 3. -3 4. -6 5. $x \geq 0$
 6. $-3 < z < 10$ 7. $P \leq 2$ 8. $W \geq 200$
 9. 2, 7 10. 0, 1

1. $-1 \leq x \leq 5$; Bounded 3. $x > 11$; Unbounded
 5. $x < -2$; Unbounded 7. c 8. h 9. f
 10. e 11. g 12. a 13. b 14. d
 15. (a) Yes (b) No (c) Yes (d) No
 17. (a) Yes (b) No (c) No (d) Yes
 19. (a) Yes (b) Yes (c) Yes (d) No
 21. $x \geq 6$ 23. $x > -4$



61. $|x| \leq 2$ 63. $|x - 9| \geq 3$ 65. $|x - 12| \leq 10$
 67. $|x + 3| > 5$ 69. More than 400 miles
 71. Greater than 12.5% 73. 24 weeks
 75. (a)

x	10	20	30	40	50
R	\$1159.50	\$2319.00	\$3478.50	\$4638.00	\$5797.50
C	\$1700.00	\$2650.00	\$3600.00	\$4550.00	\$5500.00

- (b) $x \geq 36$ units
 77. Less than 24,062.5 miles 79. $x \geq 128.93$
 81. 2005 ($t < 15.07$) 83. $[\approx 106.864, \approx 109.464]$
 85. Overcharged or undercharged up to \$0.47
 87. $[65.8, 71.2]$ 89. $[20, 80]$

Math Matters (page R137)

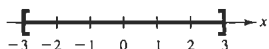
Cube	Ratio of $\frac{\text{surface area}}{\text{weight}}$
1	6
2	3
3	2
4	1.5

Section R2.7 (page R145)

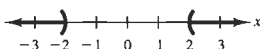
Warm Up (page R145)

1. $y < -6$ 2. $z > -\frac{9}{2}$ 3. $-3 \leq x < 1$
 4. $x \leq -5$ 5. $-3 < x$ 6. $5 < x < 7$
 7. $-\frac{7}{2} \leq x \leq \frac{7}{2}$ 8. $x < 2, x > 4$
 9. $x < -6, x > -2$ 10. $-2 \leq x \leq 6$

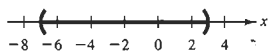
1. $-3 \leq x \leq 3$



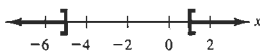
3. $x < -2, x > 2$



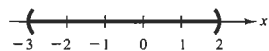
5. $-7 < x < 3$



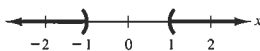
7. $x \leq -5, x \geq 1$



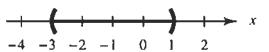
9. $-3 < x < 2$



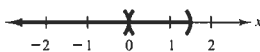
11. $x < -1, x > 1$



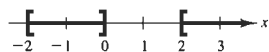
13. $-3 < x < 1$



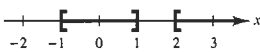
15. $x < 0, 0 < x < \frac{3}{2}$



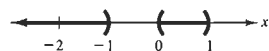
17. $-2 \leq x \leq 0, x \geq 2$



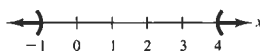
19. $-1 \leq x \leq 1, x \geq 2$



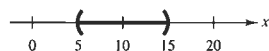
21. $x < -1, 0 < x < 1$



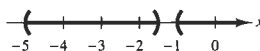
23. $x < -1, x > 4$



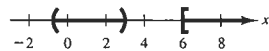
25. $5 < x < 15$



27. $-5 < x < -\frac{3}{2}, x > -1$



29. $-\frac{3}{4} < x < 3, x \geq 6$



31. $[-2, 2]$

33. $-\frac{9}{2} \leq x \leq \frac{9}{2}$ 35. $(-\infty, 3], [4, \infty)$

37. All real numbers 39. All real numbers

41. The cube root of any real number is a real number.

43. $-3.51 < x < 3.51$ 45. $-0.13 < x < 25.13$

47. $2.26 < x < 2.39$ 49. Between 4 and 6 seconds

51. $\approx 13.8 \text{ meters} \leq l \leq \approx 36.2 \text{ meters}$

53. (a) $90,000 \leq x < 100,000$ (b) $\$30 \leq p \leq \32

(c) 185,968 units

55. 9.5% 57. 2006 ($t > 15.71$)

59. 2006/2007 ($t > 17.28$)

Review Exercises (page R150)

1. Conditional equation

3. (a) No (b) Yes (c) Yes (d) No

5. $-\frac{1}{2}$ 7. -10 9. $-\frac{2}{3}$ 11. 377.778 13. 12

15. $130 - x = 100$; 30 pounds 17. 29.5 feet \times 59 feet

19. \$12 21. \$161.25 23. 2 hours

25. ≈ 2.9 quarts 27. $-\frac{1}{2}, \frac{4}{3}$ 29. 3, 8

31. $\pm\sqrt{11}, \approx \pm 3.32$

33. $-4 + 3\sqrt{2} \approx 0.24$

$-4 - 3\sqrt{2} \approx -8.24$

35. (1) Use the *table* feature in ASK mode with the variable equal to a solution.

(2) Use the scientific calculator portion of the graphing utility to evaluate the quadratic equation at a particular solution.

37. 15 feet \times 27 feet 39. 200,000 units or 300,000 units

41. Two real solutions 43. $6 \pm \sqrt{6}$

45. $\frac{-19 \pm \sqrt{165}}{2}$ 47. $-3 \pm 2\sqrt{3}$

49. 1.866, -0.283 51. Moon: ≈ 6.09 seconds
 Earth: 2.5 seconds

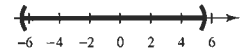
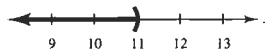
53. 0, -1, 4 55. $-3, \sqrt[3]{5}$ 57. $\frac{25}{4}$ 59. No solution

61. $\pm 4\sqrt{2}$ 63. $-3, \frac{7}{5}$

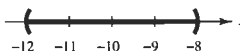
65. $2 \pm \sqrt{19}$ 67. \$600 69. $\approx 21.2\%$

71. $x < 11$

73. $-\frac{13}{2} < x < \frac{11}{2}$



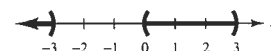
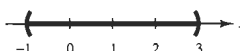
75. $-12 < x < -8$



77. $x \geq 36$ units

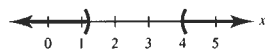
79. $-1 < x < 3$

81. $x < -3, 0 < x < 3$



83. $x < \frac{6}{5}, x > 4$

85. $-1.69 < x < 1.69$



87. $1.65 < x < 1.74$ 89. $x \geq 10$

91. All real numbers 93. $x \leq 6$ or $x \geq 9$

95. Between 3.65 and 4.72 seconds

97. Greater than 6.96% 99. $25,359 \leq x \leq 94,641$

101. (a)

t	0	5	10	11
R	188,175	207,047	225,919	229,693

(b) 2009 ($t \geq 19.03$)

Chapter Test (page R154)

1. $\frac{17}{23}$ 2. (a) All real numbers (b) $-3 \leq x \leq 3$

3. April: \$175,364.00 4. $-\frac{5}{3}, \frac{1}{2}$ 5. 4, $-\frac{3}{2}$
 May: \$140,291.20

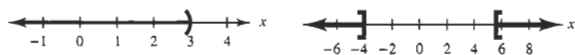
6. $\pm\sqrt{15}$ 7. $\frac{-13 \pm \sqrt{69}}{2}$ 8. $\frac{11 \pm \sqrt{145}}{6}$

9. 1.038, -0.446 10. 2, $-\frac{10}{3}$ 11. 4

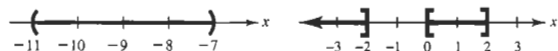
12. -1, 1, -3, 3 13. -6, 6

14. Selling either 341,421 units or 58,579 units will produce a revenue of \$2,000,000.

15. $x < 3$ 16. $x \leq -4, x \geq \frac{28}{5}$



17. $(-11, -7)$ 18. $x \leq -2, 0 \leq x \leq 2$



19. More than 10,839 units but less than 129,161 units

20. 2004 ($t > 23.8$)

Cumulative Test: Chapters R1-R2 (page R155)

1. $-32x^6$ 2. $3x^2\sqrt{2x}$ 3. $\frac{3 + \sqrt{5}}{2}$

4. $(x + \sqrt{3})(x - \sqrt{3})(x - 6)$ 5. $\frac{x + 4}{5}, x \neq 4$

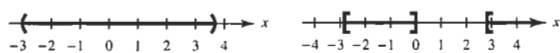
6. $\frac{y-x}{x+y}, xy \neq 0$

7. (a) 172,000,000 (b) 2006 ($t = 15.84$)

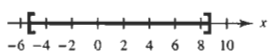
8. $5, \frac{1}{2}$ 9. 0.734, -1.022 10. $\frac{8}{3}, -\frac{10}{3}$

11. $5 - 2\sqrt{2}$ 12. $\pm 1, \pm 4$ 13. $\pm 3\sqrt{2}$

14. $-3 < x < \frac{11}{3}$ 15. $-2\sqrt{2} \leq x \leq 0, x \geq 2\sqrt{2}$



16. $-\frac{16}{3} \leq x \leq \frac{26}{3}$



17. At least 10,470 units but no more than 222,864 units

18. 2007 ($t > 16.97$)

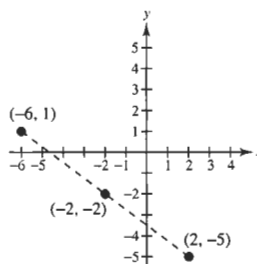
Chapter 1

Section 1.1 (page 12)

Warm Up (page 12)

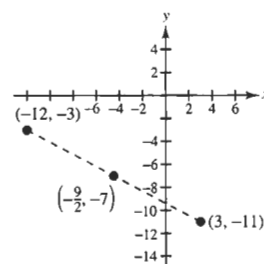
1. 5 2. $3\sqrt{2}$ 3. 1 4. -2
 5. $3(\sqrt{2} + \sqrt{5})$ 6. $2(\sqrt{3} + \sqrt{11})$ 7. -3, 11
 8. 9, 1 9. 0, ± 3 10. ± 2

1. (a)



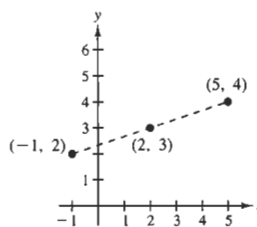
(b) 10 (c) $(-2, -2)$

3. (a)



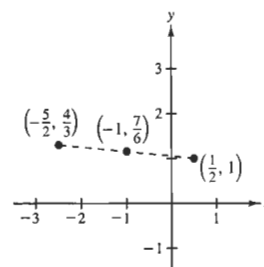
(b) 17 (c) $(-\frac{9}{2}, -7)$

5. (a)



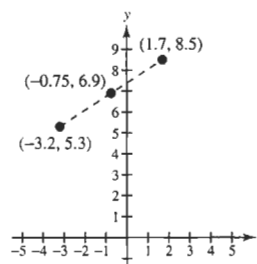
(b) $2\sqrt{10}$ (c) (2, 3)

7. (a)



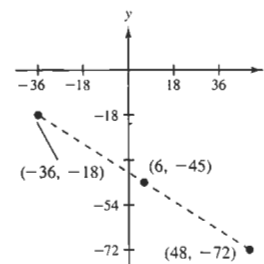
(b) $\frac{\sqrt{82}}{3}$ (c) $(-1, \frac{7}{6})$

9. (a)



(b) $\sqrt{34.25}$ (c) $(-0.75, 6.9)$

11. (a)



(b) $6\sqrt{277}$ (c) (6, -45)

13. 5 15. $\sqrt{109}$ 17. $x = 15, -9$ 19. $y = 9, -23$

21. (a) Yes (b) Yes 23. (a) Yes (b) Yes