Answer Key

Chapter 1: Whole Numbers

1.1 Exercises

Concept Check

1. 1

3. Counting

5. 4

7. Forty thousand, seven hundred eighty-two

9. True

Practice

1. **a.** 6 **b.** 8 **c.** 0

3. **a.** Ten thousands

b. Hundreds **c.** Ones

5. 2: ten thousands,
4: thousands,
6: hundreds, 8 ones

7. 2: billions,
4: hundred millions,
3: millions,
1: hundred thousands,
8: ten thousands,
9: thousands, 5: hundreds

9. Eight hundred thirty-five

11. Thirty thousand, two hundred one

13. Six hundred eighty-three thousand, one hundred

15. Sixteen million, three hundred two thousand, five hundred ninety

17. 580 **19.** 2005

21. 3834 **23.** 78,902

25. 63,065 **27.** 400,736

29. 82,700,000

31. 35,960,013

Applications

33. Eighty-two thousand, one hundred three

35. One hundred ten; Two thousand six hundred fifty

37. Three hundred fifty-two thousand, one hundred forty-three; Nine hundred twelve thousand, fifty

39. Ten thousand, six hundred sixty-seven; sixty-six thousand, four hundred ninety-six

41. 8520; 2000

43. 44; 218,792

45. 193,046; 184,327

47. 10,533,871; 3,154,000

49. No; 480,105

51. Sam Burns

53. Will Zalatoris

55. Seven million, twelve thousand, six hundred seventy-two

57. *Wicked*

59. *Plaza Suite*, seven thousand, seven hundred ninety-one

61. *Plaza Suite, Moulin Rouge! The Musical, MJ The Musical,* and *Six*

63. *Wicked*

65. *Venom: Let There Be Carnage*

67. $183,651,655; One hundred eighty-three million, six hundred fifty-one thousand, six hundred fifty-five dollars

Writing & Thinking

69. 10^{100}

71. Hyphens are used for two-digit numbers larger than 20 that do not end in a zero.

1.2 Exercises

Concept Check

1. sum

3. associative

5. perimeter

7. False; A polygon has three or more sides.

9. False; Borrowing must occur.

Practice

1. 16

3. 10

5. 25

7. Commutative property of addition

9. Associative property of addition

11. Additive identity

13. 78 **15.** 74

17. 361 **19.** 689

21. 16,072 **23.** 10,500

25. 53,904 **27.** 329,134

29. 835 **31.** 529

33. 2,140,589

35. 11 **37.** 144

39. 13 **41.** 25

43. 94 **45.** 376

47. 593 **49.** 1531

51. 1424 **53.** 694

55. 2,806,644

57. 1,006,958

59. 45 cm **61.** 108 ft

63. 31 m

Applications

65. 250 yards

67. $1053

69. 2762 miles

71. **a.** 125 **b.** Yes, $125 \le 125$

73. 222 **75.** 18 gallons

77. $480,000 **79.** $67

81. $39,100

83. Company A; $7000

85. **a.** Utilities $262;
Car costs $585

b. $2482 **c.** $1018

Writing & Thinking

87. Commutative property of addition, associative property of addition, and additive identity property; Examples will vary.

89. Borrowing is required when a digit is smaller than the digit being subtracted; Examples will vary.

1.3 Exercises

Concept Check

1. product

3. 0 (or zero)

5. grouping

7. False; The numbers being multiplied are called factors.

9. True

Practice

1. 168 **3.** 162

5. 854 **7.** 2808

9. 1760 **11.** 2352

13. 4233 **15.** 1054

17. 7632 **19.** 2850

21. 21,500 **23.** 43,680

25. 3,305,565

27. 6,036,009

29. 0 **31.** 8300

33. Zero-factor law

35. Associative property of multiplication

37. Commutative property of multiplication

39. Multiplicative identity

41. $x = 2$; Associative property of multiplication

43. $a = 0$; Zero-factor law

45. $n = 1$; Multiplicative identity

47. $x = 8$; Commutative property of multiplication

49. 900

51. 2500
53. 4000
55. 160,000
57. 1,500,000
59. 320,000,000
61. $3 \cdot 9 + 3 \cdot 7 = 27 + 21 = 48$
63. $6 \cdot 3 + 6 \cdot 11 = 18 + 66 = 84$
65. 25 square yards
67. 63 square meters

Applications

69. $2975
71. 360 minutes; 2520 minutes
73. 9250 calories
75. $284,400
77. $23
79. 648 square feet
81. 10,080 square feet

Writing & Thinking

83. Zero times any number is 0.
85. The distributive property distributes multiplication to two (or more) numbers that are being added; Examples will vary.

1.4 Exercises

Concept Check

1. Divisor **3.** 1
5. Undefined **7.** True
9. False; $\frac{0}{7} = 0$.

Practice

1. 7 **3.** 12
5. 0 **7.** 5 R2
9. Undefined
11. 40 **13.** 41
15. 44 R2 **17.** 9
19. 24 **21.** 50
23. 15 R12 **25.** 15 R5
27. 28 R7 **29.** 2 R2
31. 20 R3 **33.** 3 R6
35. 400 R6
37. 61 R15
39. 196 R370
41. 407
43. $704 \div 22 = 32$; $704 \div 32 = 22$
45. $1575 \div 45 = 35$; $1575 \div 35 = 45$

Applications

47. 3 cookies
49. 19 students
51. 6 hours
53. 22 teams
55. 427 square feet
57. 5423 dozen
59. $4837 per piano
61. 720 pounds
63. 9 games with $6 left over

Writing & Thinking

65. The main terms used in division are: dividend, divisor, quotient, and remainder. Examples will vary.
67. Division can be thought of as the reverse of multiplication and as a result, can be used to check the result of a multiplication problem. Answers will vary.

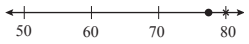
1.5 Exercises

Concept Check

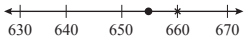
1. Right **3.** Place
5. 0s **7.** True
9. True

Practice

1. 80;



3. 660;



5. 500;

7. **a.** 2 **b.** 6 **c.** 6, 2, 3, 6 **d.** 1430, ten
9. 30 **11.** 30
13. 500 **15.** 1000
17. 100 **19.** 600
21. 4200 **23.** 10,000
25. 7000 **27.** 10,000
29. 62,000 **31.** 14,000
33. 10,000
35. 60,000
37. 130,000
39. 1,600,000
41. 220; 223
43. 800; 789
45. 21,000; 21,141
47. 500; 487
49. 20,000; 20,804
51. 210,000; 181,300
53. **a.** C **b.** D **c.** B **d.** E **e.** A
55. **a.** C **b.** A **c.** E **d.** D **e.** B
57. 240; 224
59. 600; 544
61. 40,000; 43,680
63. 10; 12
65. 20; 20 R13
67. 60; 61 R15

Applications

69. 4560 widgets
71. $8600
73. $26,000
75. 100,000 miles
77. $40,000; $35,316
79. $1100; $1076
81. 330 sets; 316 sets
83. $6000; $7634
85. 40 vans; 36 vans
87. $3000; $3160

Writing & Thinking

89. Estimation uses rounded values to find an approximate sum, difference, product, etc. Answers will vary.
91. Rounding is used to find another number close to the given number. Estimation uses rounded values to find an approximate sum, difference, product, etc. Answers will vary.

1.6 Exercises

Concept Check

1. multiplication
3. read
5. check, reasonable
7. True
9. False; Quotient indicates division.

Applications

1. 1103 calories
3. 420 syringes
5. 648 miles
7. 64 people
9. 300 pens
11. 768 beads
13. 26 cans **15.** $1175
17. $691 **19.** $384
21. $160 **23.** $255
25. $85 **27.** $150
29. Blue car for $9112; $33 cheaper
31. 174 cm
33. 82 in.
35. 380 sq in
37. 348 sq ft
39. 54 **41.** 485
43. 6 **45.** $321
47. 7 hours **49.** $125
51. 21 points
53. $76.60/share; $100 profit
55. **a.** 12 pairs of shoes
b. 254 pairs of shoes
57. 3873 miles

Writing & Thinking

59. **1.** Read the problem carefully. **2.** Draw any type of figure or diagram that might be helpful and decide what operations are needed. **3.** Perform the operations to solve the problem. **4.** Check your work.
61. Answers will vary. Averages may be used when looking at attendance, money made per month, commute time, etc.

1.7 Exercises

Concept Check

1. coefficient

3. equivalent

5. Addition, Subtraction, Division

7. False; Evaluating expressions and solving equations are related concepts.

9. False; The solution to the equation $n + 3 = 10$ is 7.

Practice

1. 5 is a solution

3. 10 is not a solution

5. 5 is a solution

7. $x = 4$ **9.** $13 = x$

11. $y = 0$ **13.** $10 = n$

15. $x = 4$ **17.** $y = 4$

19. $4 = n$ **21.** $x = 6$

23. $x = 7$ **25.** $y = 4$

27. $6 = y$ **29.** $9 = y$

31. $x = 14$ **33.** $x = 5$

35. $x = 12$ **37.** $3 = y$

39. $9 = x$ **41.** $x = 3$

43. $0 = x$ **45.** $0 = x$

47. $5 = x$ **49.** $y = 7$

Applications

51. No; \$24 is not a solution to the equation.

53. 9 pounds

55. \$9

57. 240 screws

59. \$11,675

Writing & Thinking

61. Substituting the value in for the variable will result in a true equation; Answers will vary.

63. **a.** $x = c - b$

b. 1 unique solution

1.8 Exercises

Concept Check

1. Cubed

3. Base, exponent

5. 1

7. False; Equals 81

9. False; 7^0 is 1.

Practice

1. 11^3

3. 7^4

5. $2^3 \cdot 3^2$

7. $5^3 \cdot 7^2$

9. $2 \cdot 3^2 \cdot 11^2$

11. **a.** 4 **b.** 2 **c.** 16

13. **a.** 2 **b.** 3 **c.** 8

15. **a.** 1 **b.** 6 **c.** 1

17. **a.** 5 **b.** 3 **c.** 125

19. **a.** 2 **b.** 4 **c.** 16

21. **a.** 9 **b.** 2 **c.** 81

23. **a.** 7 **b.** 2 **c.** 49

25. **a.** 3 **b.** 5 **c.** 243

27. **a.** 30 **b.** 2 **c.** 900

29. **a.** 20 **b.** 3 **c.** 8000

31. **a.** 1 **b.** 57 **c.** 1

33. **a.** 4 **b.** 0 **c.** 1

35. **a.** 13 **b.** 1 **c.** 13

37. **a.** 22 **b.** 0 **c.** 1

39. 21 **41.** 19

43. 28 **45.** 21

47. 2 **49.** 12

51. 12 **53.** 9

55. 0 **57.** 5

59. 46 **61.** 13

63. 74 **65.** 9

67. 132 **69.** 261

71. 61 **73.** 994

Applications

75. **a.** No. Here it shows that we are only dividing the old trading cards by 6 friends versus both the old and new trading cards by 6 friends.

b. 522; $\frac{15 \cdot 10 \cdot 20 + 132}{6}$

77. **a.** No. The formula shows that we are using $\frac{126}{4}$ yards of fabric to make only skirts, not full dresses. Adding 2 yards of silk after will only be enough for 1 bodice.

b. 20; $\frac{126}{4 + 2}$

Writing & Thinking

79. If addition is within parentheses (or other grouping symbols), addition would be performed first.

Collaborative Learning

81. $1.024\text{E}13$, $1\text{E}20$; Answers will vary.

1.9 Exercises

Concept Check

1. 0, 5

3. 4

5. 2

7. True

9. False; 7605 is divisible by 5.

Practice

1. 3, 5

3. 2, 3, 4, 6, 9

5. 3

7. 3, 9

9. 3, 5

11. None

13. None

15. 2, 3, 4, 5, 6, 10

17. 2, 5, 10

19. 3

21. 2

23. 3, 5

25. 2, 3, 4, 6

27. 3, 9

29. 3, 5

31. 2, 3, 4, 6, 9

33. 2

35. None

37. 2, 3, 4, 5, 6, 9, 10

39. 3, 5

41. 2, 3, 6

43. 2, 3, 4, 5, 6, 9, 10

45. 2, 3, 4, 6

47. 102, 108, 114, 120; Answers will vary.

49. 120, 150, 180, 210; Answers will vary.

51. 120, 150, 180, 210; Answers will vary.

Applications

53. 3 students would get \$3375 each; 9 students would be \$1125 each.

55. 4 team members would work 110 hours each; 8 team members would work 55 hours each.

Writing & Thinking

57. **a.** 30, 45; Answers will vary.

b. 9, 12; Answers will vary.

c. 10, 25; Answers will vary.

59. For example: 15,030. The number is divisible by 3 and 9 because digits add up to 9 and the number is divisible by 5 and 10 because the number ends in 0.

61. Answers will vary. Any number that ends in 5 is divisible by 5 and not divisible by 10. Two examples are 15 and 25.

1.10 Exercises

Concept Check

1. two

3. 1

5. itself

7. False; A prime number has exactly 2 factors.

9. False; 231 is a composite number.

Practice

1. A number whose only factors are 1 and itself. Answers will vary.

3. Prime

5. Composite; 1, 3, 7, 9, 21, 63

7. Prime

9. Composite; 1, 5, 41, 205

11. Composite; 1, 11, 13, 143

13. 4, 6 **15.** 1, 12

17. 3, 8 **19.** 4, 4

21. $2^3 \cdot 3$ **23.** 3^3

25. 2^4 **27.** $2^2 \cdot 3^2$

29. $2^2 \cdot 5$ **31.** $2 \cdot 5 \cdot 7$

33. 37 is prime

35. $2 \cdot 3 \cdot 5^2$

37. $2 \cdot 3 \cdot 5 \cdot 7$

39. $2^3 \cdot 3^2 \cdot 5$

41. $2^3 \cdot 5^2 \cdot 11$

43. $2^3 \cdot 5^3$

45. **a.** $2 \cdot 3^2$

b. 1, 2, 3, 6, 9, 18

47. **a.** $2 \cdot 3 \cdot 5$

b. 1, 2, 3, 5, 6, 10, 15, 30

49. **a.** $2^2 \cdot 3 \cdot 7$

b. 1, 2, 3, 4, 6, 7, 12, 14, 21, 28, 42, 84

51. **a.** $5^2 \cdot 7$

b. 1, 5, 7, 25, 35, 175

53. **a.** $2^2 \cdot 3 \cdot 5^2$

b. 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 25, 30, 50, 60, 75, 100, 150, 300

Applications

55. 1, 2, 3, 4, 6, 8, 12, 24

57. 1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 36, 72

Writing & Thinking

59. No, some odd numbers are the product of two or more odd prime factors, for example, $3 \cdot 3 = 9$, $3 \cdot 5 = 15$, $3 \cdot 7 = 21$, etc.

61. The tests for divisibility can be used to find relatively small factors quickly. Knowing these factors makes finding the prime factorization easier.

Collaborative Learning

63. 28, 496

Chapter 2: Integers

2.1 Exercises

Concept Check

1. Integers

3. 0 (zero)

5. Absolute value

7. False; If −8 lies to the right of a number on a number line, then −8 is greater than that number.

9. True

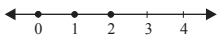
Practice

1. 3

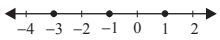
3. 0

5. –2

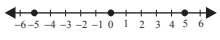
7.



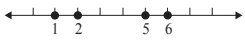
9.



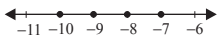
11.



13.

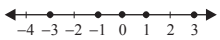


15.

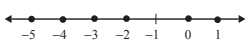


17.

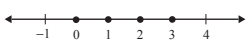
19.



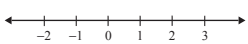
21.



23.



25.



27. < **29.** >

31. < **33.** <

35. > **37.** <

39. True **41.** True

43. True **45.** 4

47. 5 **49.** 0

51. 42 **53.** –20

55. 13 **57.** –12

59. –5, 5 **61.** –2, 2

63. 0

65. No solution

67. Sometimes. Examples will vary.

69. Sometimes. Examples will vary.

Applications

71. –4500 meters

73. +8844 meters

75. **a.** 70 °F; **b.** 84 °F

Writing & Thinking

77. Examples will vary. Temperature can be negative, zero, or positive. Altitude/elevation can be below sea level (a negative number), at sea level (0), or above sea level (a positive number). A person's banking/credit accounts can have balances that are negative, 0, or positive. A particular stock can trade lower (negative), higher (positive), or at the same price (0).

79. Absolute value is always positive or zero because it is measuring a distance. Opposites always change signs because they are located the same distance from zero but in the opposite direction so that their sign is also opposite.

2.2 Exercises

Concept Check

1. larger

3. negative

5. satisfy (or be a solution of)

7. False; When adding numbers with unlike signs, the answer can be negative or positive, depending on numbers used.

9. False; The additive inverse of negative seven is 7.

Practice

1. –15 **3.** 40

5. 9 **7.** 13

9. –8 **11.** 0

13. 9 **15.** 8

17. –2 **19.** –17

21. –4 **23.** 0

25. –30 **27.** –45

29. 23 **31.** 10

33. 3 **35.** –20

37. 11 **39.** 18

41. 14 **43.** 35

45. No **47.** Yes

49. Yes **51.** Yes

53. No **55.** –3305

57. –2575 **59.** –23,094

61. 495

Applications

63. Positive

65. –275 ft (275 feet below sea level)

67. –8 feet (8 feet below ground)

69. 8

Writing & Thinking

71. Sometimes. Examples will vary.

73. Sometimes. Examples will vary.

75. Never. Examples will vary.

77. Always. Examples will vary.

79. **a.** 10, 4 **b.** 13, –3

c. 1, –5

81. This is only possible if both integers are zero.

83. To determine if a number is a solution, substitute the number in place of the variable in the equation. If the resulting statement is true, then the number is a solution.

2.3 Exercises

Concept Check

1. subtraction

3. opposite

5. equation

7. True

9. True

Practice

1. **a.** –8 **b.** –20

3. **a.** –29 **b.** –9

5. **a.** –8 **b.** –32

7. 6 **9.** –7

11. –19 **13.** 5

15. –20 **17.** –34

19. 4 **21.** –9

23. 6 **25.** –15

27. –2 **29.** 1

31. 0 **33.** 6

35. –45 **37.** –8

39. –19 **41.** >

43. < **45.** >

47. = **49.** Yes

51. Yes **53.** Yes

55. No **57.** Yes

59. **a.** –632 **b.** 29,942

61. **a.** –174,350 **b.** –232,550

63. **a.** 17,610 **b.** –39,050

Applications

65. 6338 points

67. 10 lb loss; 215 lb

69. $215

71. 13.5 meters

Writing & Thinking

73. Answers will vary. When the absolute value of the number being subtracted is greater than the absolute value of the other number, the difference will be positive.

75. Answers will vary.

2.4 Exercises

Concept Check

1. positive

3. negative

5. addition, subtraction

7. False; The product of zero and an integer is 0.

9. True

Practice

1. 28 **3.** –24

5. 14 **7.** 0

9. 60 **11.** –14

13. –1 **15.** –50

17. 400 **19.** 0

21. 5 **23.** –4

25. –4 **27.** –2

29. –4 **31.** 0

33. Undefined

35. –64 **37.** 16

39. –64 **41.** –125

43. –3 **45.** 3

47. –14 **49.** –22

51. 39 **53.** 4

55. –6 **57.** 33

59. 27 **61.** 49

63. 45 **65.** –9

67. 4624 **69.** –105

71. 1026 **73.** –70

75. **a.** –17 **b.** –27

77. 0 **79.** –6

Applications

81. $78 per share

83. 85

85. **a.** 71 **b.** 1

87. 8 degrees Fahrenheit

Writing & Thinking

89. Negative; The product of every two negative numbers will be positive and this result multiplied by the remaining negative will give a negative answer.

91. MD in PEMDAS means multiplication and division. If a student performs all of the multiplication before performing any division, that may be a mistake as multiplication or division are to be performed as they appear from left to right. The same holds true for AS, which stands for addition and subtraction, which are to be performed as they appear from left to right.

2.5 Exercises

Concept Check

1. 1

3. constant

5. coefficients

7. True

9. False; In the term $12a$, 12 is the coefficient.

Practice

1. –5, 3, and 8 are like terms; $7x$ and $9x$ are like terms.

3. $-x^2$ and $2x^2$ are like terms; $-6xy$ and $5xy$ are like terms; $3x^2y$ and $5x^2y$ are like terms.

5. $15x$ **7.** $3x$

9. $-2n$ **11.** $5y^2$

13. $10x$ **15.** $-2c$

17. $7x + 2$ **19.** $2x^2 + 2x$

21. $3x^2 + 20$ **23.** $13x^2 - 2y$

25. $7x - 1$

27. $-2n^2 + 2n - 3$

29. $-x^2 + 3x + 45$

31. $4n + 3$ **33.** $7a - 8b$

35. $5x - 1$ **37.** $8x + y$

39. –4 **41.** 4

43. –2 **45.** –10

47. $3y + 4$; 13

49. $-2x - 8$; –16

51. $5y + 1$; 16

53. $-x - 54$; −58

55. $-x^2 + 5x - 7$; –21

57. $3y^2 - y$; 4

59. $x^3 - 2x^2 - 2x$; –12

61. $4y^3 - 4y^2 + 5y + 1$; –12

63. $5x^2 + 9x - 22$; –20

65. $2a^2 - 2a$; 4

67. $5a - b + 4$; 1

69. $14a - 15b + 2c + 2$; 24

71. $10a + 10b + 10c$; 0

Applications

73. $50,000

75. **a.** $47s + 143m$

b. 6170 boxes

Writing & Thinking

77. A number is a constant and its value does not change regardless of where it appears in an expression or equation. A variable, usually represented by a letter, represents an unknown number or numbers.

79. **a.** For $x = 3$,

$$\begin{aligned} &4x^2 - 5(x+2) + 3x + 10 + 2x \\ &= 4(3)^2 - 5(3+2) + 3(3) \\ &\quad + 10 + 2(3) \\ &= 4(9) - 5(5) + 9 + 10 + 6 \\ &= 36 - 25 + 9 + 10 + 6 \\ &= 36 \end{aligned}$$

b.

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

For $x = 3$,

$$\begin{aligned} 4x^2 &= 4(3)^2 \\ &= 4(9) = 36 \end{aligned}$$

The second method, as it requires fewer calculations.

2.6 Exercises

Concept Check

1. ambiguous

3. subtraction
5. multiplication
7. True
9. False; Subtraction is indicated by the phrase "five less than a number."

Practice

1. $x+6$ 3. $y-4$
5. $\frac{2m}{10}$ 7. $6y-4$
9. $4x+2x$ 11. $15-2y$
13. $3x-5x$ 15. $9(x+2)$
17. $4(x+1)-13$
19. $3(x+6)+8$
21. $3(7-x)-4$
23. $\frac{x}{2}-18$
25. a. $x-6$ b. $6-x$
27. a. $3x-5$ b. $5-3x$
29. $24d$ 31. $\$3.15x$
33. $365y$ 35. $7t+3$
37. $7t+3$
39. $\$20+\$0.15m$
41. $2w+2(2w-3)=6w-6$
43. Four times a number
45. A number increased by five
47. Four times a number decreased by seven
49. Seven times the sum of a number and one
51. Negative two times the difference between a number and eight
53. Five times the sum of twice a number and three
55. The quotient of six and the difference between a number and one
57. Six times a number plus the number minus one
59. Eight increased by twice the difference between a number and one
61. The sum of three times a number and seven; three times the sum of a number and seven
63. The product of seven and a number minus three; seven times the difference between a number and three

Writing & Thinking

65. The Commutative Property of Addition and Multiplication permits the order of items being added or multiplied to change and still have the same result. This property does not hold true for subtraction or division. Therefore, order is important for subtraction and division problems or the answer will change or be incorrect.
67. Answers will vary.

2.7 Exercises

Concept Check

1. solution
3. addition
5. original equation
7. True
9. False; When solving an equation of the form $ax+b=c$, if a variable has a constant coefficient other than 1, use the division principle to divide both sides by the coefficient

Practice

1. $x=-12$ 3. $y=-25$
5. $x=-15$ 7. $n=-3$
9. $x=12$ 11. $x=-32$
13. $y=-20$ 15. $x=-12$
17. $y=-9$ 19. $x=-9$
21. $x=4$ 23. $n=-21$
25. $y=-11$ 27. $x=-4$
29. $x=5$ 31. $x=-26$
33. $x=4$ 35. $n=-42$
37. $y=-6$ 39. $x=6$
41. $x=5$ 43. $x=7$
45. $n=4$ 47. $x=5$
49. $x=4$ 51. $x=3$
53. $x=8$ 55. $x=8$
57. $x=6$ 59. $y=-4$
61. $x=3$ 63. $x=9$
65. $y=-2$ 67. $n=2$
69. $x=4$ 71. $y=3$
73. $x=4$ 75. $n=-8$

Applications

77. $w=-28$ pounds
79. $x=-13$ pounds per day
81. $s=2$ inches per hour
83. $t=-2$ °F per hour

Writing & Thinking

85. Write the equation.
Simplify.
Divide both sides by 2.
Simplify.
87. Answers will vary. Because subtraction of a number can be thought of as addition of the opposite of the number, the subtraction principle can always be applied using the addition principle.

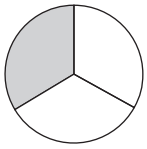
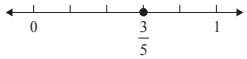
Chapter 3: Fractions, Mixed Numbers, and Proportions

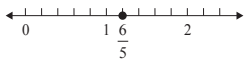
3.1 Exercises

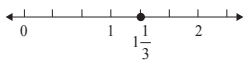
Concept Check

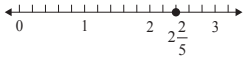
1. improper
3. mixed
5. False; In $\frac{11}{13}$, the numerator is 11.
7. True

Practice

1. a. $\frac{2}{3}$ b. $\frac{1}{3}$
3. a. $\frac{4}{7}$ b. $\frac{3}{7}$
5. a. $\frac{1}{6}$ b. $\frac{5}{6}$
7. a. $\frac{7}{12}$ b. $\frac{5}{12}$
9. a. $\frac{7}{30}$ b. $\frac{23}{30}$
11. 
13. 
15. $\frac{5}{4}$
17. $\frac{10}{4}$
19. 0
21. Undefined
23. 

25. 

27. Mixed number
29. Proper fraction
31. a. $1\frac{5}{12}$ b. $\frac{17}{12}$
33. a. $1\frac{5}{12}$ b. $\frac{17}{12}$
35. $2\frac{3}{8}$ in.
37. $1\frac{7}{8}$ in.
39. 

41. 

43. $\frac{8}{5}$ 45. $\frac{9}{4}$
47. $-\frac{29}{8}$ 49. $\frac{34}{5}$

51. $-\frac{46}{3}$ **53.** $\frac{34}{7}$

55. $-\frac{25}{2}$ **57.** $\frac{701}{100}$

59. $1\frac{1}{3}$ **61.** $6\frac{1}{2}$

63. $2\frac{7}{10}$ **65.** $-6\frac{1}{7}$

67. 3 **69.** $-2\frac{1}{3}$

71. $1\frac{87}{100}$ **73.** $-2\frac{2}{13}$

Applications

75. $\frac{9}{11}; \frac{11}{20}$

77. $\frac{23}{45}$

79. $\frac{43}{60}$

81. **a.** $\frac{1}{8}$ **b.** $\frac{1}{512}$ **c.** $\frac{159}{512}$

83. **a.** $\frac{35}{12}$ **b.** $2\frac{11}{12}$

Writing & Thinking

85. The two parts are the numerator and the denominator. The denominator represents the number of pieces in a whole and the numerator represents the number of these pieces being considered.

87. Multiply the denominator by the whole number and add the numerator. This number is the new numerator. The denominator stays the same.

3.2 Exercises

Concept Check

1. 1

3. factors

5. common

7. True

9. False; The statement $\frac{1}{3}\cdot\frac{2}{5}=\frac{2}{5}\cdot\frac{1}{3}$ is an example of the commutative property of multiplication.

Practice

1. $\frac{3}{8}$ **3.** $-\frac{4}{25}$

5. 0 **7.** $\frac{12}{1}$ or 12

9. $-\frac{12}{35}$ **11.** $\frac{15}{32}$

13. $\frac{45}{2}$ **15.** $-\frac{27}{28}$

17. $\frac{343}{216}$ **19.** $\frac{1}{8}$

21. $-\frac{4}{45}$ **23.** $\frac{2}{9}$

25. $\frac{1}{3}$ **27.** $-\frac{3}{4}$

29. $\frac{5}{11}$ **31.** 0

33. $-\frac{2}{5}$ **35.** $\frac{1}{2}$

37. $\frac{2}{3}$ **39.** $-\frac{25}{76}$

41. 4 **43.** $-\frac{3}{4}$

45. $\frac{10}{9}$ **47.** $\frac{3}{2}$

49. $-\frac{1}{4}$ **51.** $-\frac{2}{3x}$

53. $\frac{6a}{b}$ **55.** $\frac{2y}{9}$

57. $\frac{1}{4}$ **59.** $\frac{4}{35}$

61. $\frac{9}{16}$ **63.** 1

65. $-\frac{5}{77}$ **67.** $-\frac{1}{6}$

69. $\frac{10}{3}$ or $3\frac{1}{3}$

71. $-\frac{28}{45}$ **73.** $\frac{9}{4}$

75. $\frac{x}{3y}$ **77.** $\frac{9}{2}$ or $4\frac{1}{2}$

79. $-\frac{21a}{16}$

Applications

81. $\frac{1}{12}$ **83.** $\frac{3}{8}$

85. $\frac{9}{20}$ **87.** 6 in.

89. 120 square feet

91. 5 ft

93. **a.** 35 women

b. 21 women **c.** Yes

d. Pass by 3 votes

95. **a.** 1500 voters

b. 2500 voters

c. 1000 Democrats

d. 2500 voters

Writing & Thinking

97. No. If a fraction is less than 1 then its product with another number will be less than that other number. So, if the other number is less than 1, the product will be less than 1. Answers will vary.

99. To multiply two fractions, multiply the numerators, multiply the denominators, and then reduce the product to lowest terms. Examples will vary.

3.3 Exercises

Concept Check

1. reciprocal

3. $\frac{1}{5}$

5. reciprocal

7. False; The reciprocal of 1 is 1.

9. False; The reciprocal of 12 is $-\frac{1}{12}$.

Practice

1. $\frac{4}{3}$

3. –3

5. $-\frac{1}{2}$

7. No reciprocal

9. $\frac{7b}{12a}$ **11.** $\frac{8}{9}$

13. $\frac{5}{7}$ **15.** 0

17. Undefined

19. $-\frac{7}{5}$ **21.** –3

23. $\frac{1}{3}$ **25.** $\frac{4}{9}$

27. $-\frac{8}{5}$ **29.** $\frac{4}{5}$

31. $\frac{8}{3}$ **33.** 1

35. $\frac{9}{20}$ **37.** $\frac{12}{35}$

39. $\frac{7}{5}$ **41.** $-\frac{41}{12}$

43. $-\frac{5}{7}$ **45.** –1

47. $\frac{4}{3}$ **49.** $\frac{4x^2}{3y^2}$

51. $98x^2$ **53.** $-300a$

55. $-\frac{3}{16y}$ **57.** $\frac{29}{155}$

59. $-\frac{3x}{8}$

Applications

61. $\frac{12}{25}$

63. 200 years

65. **a.** More **b.** Less

c. 200 passengers

67. **a.** More **b.** Less

c. 8000 steel rods per week

Writing & Thinking

69. $0=\frac{0}{1}$ and the reciprocal would be $\frac{1}{0}$ but division by 0 is undefined. So 0 has no reciprocal.

71. $12\div 3=4$ and $12\cdot\frac{1}{3}=4$. We see that dividing by 3 is the same as multiplying by $\frac{1}{3}$, the reciprocal of 3.

73. No. For example, $\frac{4}{5}\neq\frac{5}{4}$.

3.4 Exercises

Concept Check

1. mixed

3. $\frac{16}{3}$

5. $\frac{2}{3}$

7. True

9. False; The mixed number $4\frac{1}{5}$ is equal to $\frac{21}{5}$.

Practice

1. $2\frac{1}{6}$ **3.** $\frac{2}{3}$

5. $3\frac{1}{5}$ **7.** $13\frac{1}{3}$

9. -2 **11.** 35

13. $34\frac{2}{7}$ **15.** $12\frac{1}{4}$

17. 6 **19.** $11\frac{33}{35}$

21. $1\frac{3}{10}$ **23.** $7\frac{13}{21}$

25. $-8\frac{2}{3}$ **27.** 126

29. $2\frac{1}{4}$ **31.** 18

33. $11\frac{2}{3}$ **35.** $-3\frac{1}{9}$

37. 4 **39.** $5\frac{1}{5}$

41. $1\frac{1}{2}$ **43.** $3\frac{1}{7}$

45. $1\frac{6}{25}$ **47.** $2\frac{2}{5}$

49. $1\frac{5}{6}$ **51.** $-\frac{5}{7}$

53. $18\frac{1}{2}$ **55.** $29\frac{1}{3}$

57. $\frac{3}{8}$ **59.** $\frac{25}{32}$

61. $\frac{3}{8}$ **63.** $-\frac{40}{63}$

65. $\frac{9}{32}$

Applications

67. **a.** $22\frac{1}{2}$ gallons **b.** \$45

69. 63 miles

71. **a.** $\frac{1}{4}$ **b.** $\frac{5}{8}$ of a cup

73. $7\frac{1}{2}$ ft^2

75. **a.** $34\frac{2}{3}$ in. **b.** $75\frac{1}{9}$ in.^{2}

77. $6\frac{1}{2}$ feet

79. $2\frac{12}{13}$ inches

81. **a.** 1 sq ft **b.** 23 sq ft

Writing & Thinking

83. **a.** More, since $10\frac{1}{2} > 5\frac{7}{10}$

b. $\frac{35}{19}$ or $1\frac{16}{19}$

85. $2\frac{1}{5} \div 1\frac{4}{5} = \frac{11}{5} \div \frac{9}{5} = \frac{11}{5} \cdot \frac{5}{9}$

$= \frac{11 \cdot \cancel{5}}{\cancel{5} \cdot 9} = \frac{11}{9}$

or $1\frac{2}{9}$; **1.** Convert the mixed numbers into improper fractions, **2.** Find the reciprocal of the divisor, **3.** Multiply the numerators and the denominators and reduce if possible, and **4.** Change the answer to mixed number form. (**Note:** The mixed number form is preferred, but the fraction form is acceptable.)

3.5 Exercises

Concept Check

1. multiples

3. prime factorization

5. 100

7. True

9. True

Practice

1. 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

3. 12, 24, 36, 48, 60, 72, 84, 96, 108, 120, 132, 144

5. 30 **7.** 15

9. 30 **11.** 30

13. 150 **15.** 40

17. 66 **19.** 10

21. 36 **23.** 60

25. 120

27. **a.** LCM = 150

b. $150 = 10 \cdot 15 = 15 \cdot 10 = 25 \cdot 6$

29. **a.** LCM = 120

b. $120 = 6 \cdot 20 = 24 \cdot 5 = 30 \cdot 4$

31. **a.** LCM = 180

b. $108 = 12 \cdot 9 = 18 \cdot 6 = 27 \cdot 4$

33. **a.** LCM = 2520

b. $1260 = 20 \cdot 63 = 28 \cdot 45 = 45 \cdot 28$

35. $72rst^2$ **37.** $30xy^2z$

39. $100a^2b^3$ **41.** $60x^2y$

43. $72a^2b^3$ **45.** x^2y^3z

47. $450x^3y^2z$ **49.** $600x^4$

51. 15 **53.** 4

55. 42 **57.** 54

59. 60 **61.** 44

63. 32 **65.** 48

67. 42 **69.** 110

71. -20 **73.** $15x$

Applications

75. **a.** 60 minutes

b. 4, 3, and 2 trips, respectively

77. **a.** 840 days

b. 105, 70, 60, and 56 trips, respectively

79. **a.** 840 seconds

b. 24 laps, 21 laps, and 20 laps, respectively

81. **a.** 120 hours **b.** 15 orbits and 8 orbits, respectively

83. Every 180 days

85. 60 years

Writing & Thinking

87. Since the LCM is constructed using the prime factors of each number in the set, by definition, each number will divide the LCM.

89. Multiplying the two numbers together will give the LCM if those two numbers have no common factors. If they have any factors in common, then you would only use that common factor once. Examples will vary.

3.6 Exercises

Concept Check

1. denominators

3. denominators

5. equivalent

7. True

9. False; When subtracting fractions, subtract the numerators and keep the common denominator.

Practice

1. $\frac{3}{2}$ **3.** -2

5. $\frac{1}{5}$ **7.** $-\frac{1}{12}$

9. $\frac{3}{4}$ **11.** $\frac{11}{8}$

13. $\frac{2}{15}$ **15.** $\frac{62}{45}$

17. $\frac{13}{12}$ **19.** $-\frac{3}{4}$

21. 1 **23.** $\frac{17}{20}$

25. $\frac{11}{15}$ **27.** $-\frac{11}{20}$

29. $\frac{317}{1000}$ **31.** $\frac{5134}{1000}$

33. $\frac{3}{5}$ **35.** $-\frac{1}{2}$

37. $-\frac{2}{3}$ **39.** $\frac{1}{2}$

41. $-\frac{5}{16}$ **43.** $\frac{13}{20}$

45. $-\frac{1}{4}$ **47.** $\frac{1}{10}$

49. $\frac{23}{16}$ **51.** 0

53. $\frac{87}{100}$ **55.** $\frac{3}{50}$

57. $-\frac{15}{14}$ **59.** $\frac{3}{2}$

61. $\frac{2}{x}$ **63.** $\frac{(72+x)}{9x}$

65. $\frac{(15+2y)}{36}$ **67.** $\frac{6x-7}{15x}$

69. $\frac{15-8y}{12y}$ **71.** $\frac{15x-26}{24}$

Applications

73. 1 ounce

75. $\frac{23}{20}$ inches

77. $\frac{5}{8}$ inch

79. **a.** $\frac{5}{18}$ **b.** \$6000

81. $\frac{7}{24}$

83. $\frac{11}{36}$

85. **a.** $\frac{3}{4}$

b. 0 (the pie is totally consumed)

87. $\frac{23}{45}$ of the assignment

Writing & Thinking

89. The LCM finds the least common multiple of a set of numbers. The LCD does the same thing for the set of numbers determined by the denominators.

91. Answers will vary. Adding with fractions may be used when cooking or when measuring sewing or construction materials. Subtracting with fractions may be used when cooking or when measuring sewing or construction materials.

3.7 Exercises

Concept Check

1. mixed number, whole numbers

3. reduced (or simplified)

5. improper, 1

7. True

9. False; LCDs are required when adding or subtracting mixed numbers.

Practice

1. 10 **3.** $12\frac{3}{4}$

5. $20\frac{25}{28}$ **7.** $10\frac{3}{8}$

9. $8\frac{10}{21}$ **11.** $12\frac{7}{20}$

13. $7\frac{13}{35}$ **15.** $12\frac{7}{27}$

17. $12\frac{17}{24}$ **19.** $22\frac{29}{30}$

21. $11\frac{27}{70}$ **23.** $1\frac{5}{12}$

25. $4\frac{3}{5}$ **27.** $4\frac{2}{3}$

29. $3\frac{11}{20}$ **31.** 17

33. $7\frac{3}{40}$ **35.** $16\frac{5}{24}$

37. $5\frac{1}{2}$ **39.** $\frac{1}{3}$

41. $10\frac{9}{10}$ **43.** $2\frac{16}{21}$

45. $-5\frac{3}{8}$ **47.** $-12\frac{1}{4}$

49. $-5\frac{9}{20}$ **51.** $4\frac{1}{4}$

53. $-6\frac{5}{6}$ **55.** $-28\frac{7}{12}$

57. $13\frac{13}{30}$ **59.** $-45\frac{3}{20}$

Applications

61. $8\frac{7}{12}$ hours

63. $12\frac{1}{8}$ inches

65. \$404 million

67. $4\frac{13}{20}$ parts

69. $\frac{3}{5}$ hours

71. $\frac{5}{6}$ hour

73. $\frac{3}{4}$ hour

75. $3\frac{1}{4}$ pounds

77. **a.** \$$378\frac{9}{10}$ million

b. \$$27\frac{1}{2}$ million

c. \$$48\frac{1}{5}$ million

Writing & Thinking

79. Fractions should be first in case the fraction being subtracted is larger than the other fraction and 1 needs to be borrowed from the whole number.

81. **a.** 6 **b.** 600 **c.** 60,000

83. **a.** 4 **b.** 11 **c.** 100

3.8 Exercises

Concept Check

1. numerators

3. multiplication, division

5. divide

7. True

9. True

Practice

1. $\frac{3}{4}$ by $\frac{1}{12}$

3. $\frac{7}{10}$ by $\frac{1}{6}$

5. $\frac{17}{20}$ by $\frac{1}{20}$

7. $\frac{13}{20}$ by $\frac{1}{40}$

9. Equal

11. $\frac{3}{8}, \frac{2}{5}, \frac{1}{2}; \frac{1}{8}$

13. $\frac{1}{4}, \frac{1}{3}, \frac{1}{2}; \frac{1}{4}$

15. $\frac{7}{9}, \frac{31}{36}, \frac{17}{18}; \frac{1}{6}$

17. $\frac{8}{9}, \frac{9}{10}, \frac{11}{12}; \frac{1}{36}$

19. $\frac{20}{10,000}, \frac{3}{1000}, \frac{1}{100}; \frac{1}{125}$

21. $\frac{2}{3}$ **23.** $-\frac{1}{5}$

25. $\frac{1}{4}$ **27.** $\frac{89}{9} = 9\frac{8}{9}$

29. $\frac{8}{39}$ **31.** $-\frac{1}{5}$

33. $\frac{15}{64}$ **35.** $\frac{14}{45}$

37. $-\frac{5}{8}$ **39.** $\frac{29}{36}$

41. 1 **43.** $\frac{1}{5}$

45. $-\frac{125}{21}$ or $-5\frac{20}{21}$

47. $\frac{2}{3}$

49. $\frac{791}{120} = 6\frac{71}{120}$

51. $-\frac{63}{25}$ or $-2\frac{13}{25}$

53. $\frac{3}{2} = 1\frac{1}{2}$ **55.** $\frac{15x-13}{15}$

57. $\frac{4x+13}{4}$ **59.** $\frac{3-2x}{7x}$

61. $\frac{3}{2} = 1\frac{1}{2}$ **63.** $\frac{5}{3} = 1\frac{2}{3}$

65. $\frac{26}{135}$ **67.** -2

69. $\frac{21}{22}$ **71.** $\frac{22}{45}$

73. $\frac{47}{40} = 1\frac{7}{40}$

75. $\frac{223}{32} = 6\frac{31}{32}$

77. $\frac{2123}{360} = 5\frac{323}{260}$

Applications

79. $\frac{543}{40} = 13\frac{23}{40}$

81. 43 inches

83. 375

85. 17 pounds

87. **a.** $\frac{1}{3}$ kg **b.** \$6

89. $\frac{91}{48} = 1\frac{43}{48}$ feet

Writing & Thinking

91. **a.** Yes; If both fractions are greater than one half, the sum will be greater than one

b. No; Multiplying a number by a fraction between 0 and 1 results in a product that is less than the original number.

93. **a.** Less than **b.** Less than

3.9 Exercises

Concept Check

1. solutions

3. multiplication

5. LCM (least common multiple)

7. True

9. False; The equation $\frac{3}{4}x = \frac{8}{15}$ can be solved by multiplying both sides of the equation by $\frac{4}{3}$.

Practice

1. Write the equation.
Add 12 to both sides.
Simplify.
Divide both sides by 4.
Simplify.

3. Write the equation.
Multiply each term by 3.
Simplify.
Add 2 to both sides.
Simplify.
Divide both sides by 4.
Simplify.

5. $x = \frac{1}{3}$ **7.** $x = \frac{13}{3}$

9. $n = -\frac{14}{5}$ **11.** $n = -\frac{5}{2}$

13. $x = -\frac{25}{2}$ **15.** $x = -\frac{2}{3}$

17. $x = 20$ **19.** $y = -40$

21. $x = -\frac{5}{6}$ **23.** $n = -\frac{27}{4}$

25. $x = 64$ **27.** $x = 20$

29. $x = -210$ **31.** $x = \frac{70}{3}$

33. $y = -\frac{10}{3}$ **35.** $y = 7$

37. $y = \frac{14}{15}$ **39.** $n = 2$

41. $x = \frac{55}{8}$ **43.** $x = \frac{5}{3}$

45. $x = -\frac{1}{4}$ **47.** $x = -\frac{1}{8}$

49. $x = -4$ **51.** $y = \frac{21}{5}$

Applications

53. $1\frac{3}{4}$ pounds

55. 11 g of fat

57. $\frac{1}{30}$ of the project

59. $3\frac{1}{4}$ pounds of apples

61. \$64

Writing & Thinking

63. Student did not distribute when multiplying through by the LCD. Correct answer is $x = \frac{4}{3}$ or $1\frac{1}{3}$; Answers will vary.

3.10 Exercises

Concept Check

1. ratio **3.** reduced

5. 1 **7.** True

9. False; The ratio 8:2 can be reduced to the ratio 4:1.

Practice

1. $\frac{9}{14}$ **3.** $\frac{4}{3}$

5. $\frac{4}{5}$ **7.** $\frac{11}{16}$

9. $\frac{7}{24}$ **11.** $\frac{1}{2}$

13. $\frac{4}{1}$ or 4

15. $\frac{1 \text{ minute}}{40 \text{ seconds}}$ or $\frac{3}{2}$

17. $\frac{3}{4}$

19. $\frac{4}{7}$

21. $\frac{\$2 \text{ profit}}{\$5 \text{ invested}}$

23. $\frac{1 \text{ teacher}}{12 \text{ students}}$

25. $\frac{1 \text{ hit}}{5 \text{ times at bat}}$

27. $\frac{10 \text{ children}}{3 \text{ families}}$

29. $\frac{5 \text{ scholarships}}{42 \text{ students}}$

31. 60 miles per hour

33. 25 miles per gallon

35. 42 words per minute

37. 90 gallons per person

39. \$12.75 per hour

41. \$25/pair; \$24/pair; 5 pairs at \$120

43. \$3/pair; \$4/pair; 6 pairs for \$18

45. \$9/quart; \$10/quart; 4 quarts for \$36

47. \$28/bush; \$26/bush; \$25/bush; \$24/bush; 4 bushes for \$96

Applications

49. $\frac{3 \text{ fat grams}}{10 \text{ grams}}$

51. $\frac{12 \text{ clear days}}{61 \text{ cloudy days}}$

53. $\frac{3}{4}$ **55.** $\frac{10}{7}$

57. $\frac{36}{5}$ **59.** $\frac{3}{2}$

61. $\frac{1}{12}$ **63.** $\frac{4}{5}$

65. $\frac{4}{15}$

67. **a.** $\frac{7}{3}$ **b.** $\frac{3}{7}$

69. 25 miles per gallon

71. 74 applicants per opening

73. 5 ipads per classroom

75. \$75 per person

77. The player made 3 baskets for every 10 shots attempted.

79. 15 fence posts for \$510

81. \$8 per tumbler

83. \$114 per rug

85. \$14 per calculator

87. **a.** 31 miles per gallon

b. No; 31 miles per gallon is lower than the advertised amount.

89. 63 miles per hour is lower than the posted speed limit.

Writing & Thinking

91. The ratio can be written as $\frac{5}{3}$, 5:3, or 5 to 3. The preferred method is as a fraction because it is easier to simplify and manipulate in mathematical operations.

93. **a.** A ratio with different units in the numerator and denominator (the units do not cancel out); Answers will vary.

b. A rate with a denominator value of 1 unit; Answers will vary.

c. The average price for each unit of an item containing multiple units; Answers will vary.

3.11 Exercises

Concept Check

1. cross products or two ratios

3. rf and kt

5. units

7. False; Cross products are used to determine if a proportion is true.

9. False; When using proportions to solve a word problem, there are many correct ways to set up the proportion.

Practice

1. True **3.** True

5. True **7.** True

9. False **11.** True

13. True **15.** False

17. True **19.** False

21. $x = 10$ **23.** $x = 50$

25. $D = 100$ **27.** $A = \frac{21}{2}$

29. $x = 1$ **31.** $y = 6$

33. $x = \frac{1}{4}$ **35.** $R = 50$

37. $A = 27\frac{3}{10}$

39. $B = 6\frac{3}{4}$

41. $B = 7\frac{4}{5}$

43. $x = 1\frac{1}{2}$

45. $B = 90$

47. $x = 25$ hr

49. $x = 20$ ounces

51. $x = 135$ min

Applications

53. They are the same.

55. They are the same.

57. They are different.

59. They are different.

61. \$25

63. 180 minutes or 3 hours

65. \$6 **67.** $1\frac{1}{2}$ cups

69. 33 hits **71.** 450 grams

73. 20 yards **75.** $400

77. 9 hours **79.** 220 pounds

81. $160,000

83. 109,500 times

Writing & Thinking

85. A proportion has been set up correctly if the same units are in the same location in both ratios.

87. Traci's proportion has inches in the numerator in one ratio and in the denominator in the other. The units should be the same in the numerators and the same in the denominators. This means she should have used the proportion

$$\frac{4 \text{ inches}}{300 \text{ miles}} = \frac{x}{750 \text{ miles}}$$

or

$$\frac{300 \text{ miles}}{4 \text{ inches}} = \frac{750 \text{ miles}}{x}.$$

3.12 Exercises

Concept Check

1. tree

3. probability

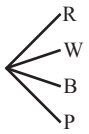
5. sample space

7. False; The individual result of an experiment is an outcome.

9. True

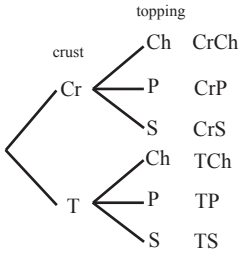
Applications

1.



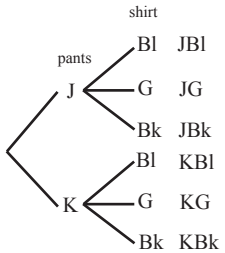
S = {R, W, B, P}
R = red, W = white,
B = blue, P = purple

3.



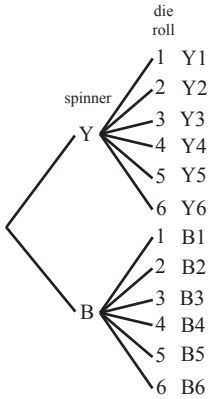
S = {CrCh, CrP, CrS, TCh, TP, TS}
Cr = crispy, T = thick,
Ch = cheese, P = pepperoni,
S = sausage

5.



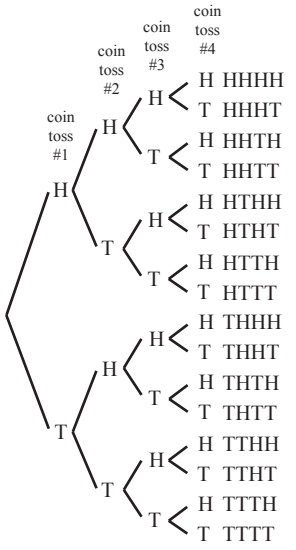
S = {JBl, JG, JBk, KBl, KG, KBk}
J = jeans, K = khaki pants, Bl = blue,
G = green, Bk = black

7.



S = {Y1, Y2, Y3, Y4, Y5, Y6
B1, B2, B3, B4, B5, B6}
Y = yellow, B = blue

9.



S = {HHHH, HHHT, HHTH, HHTT,
HTHH, HTHT, HTTH, HTTT, THHH
THHT, THTH, THTT, TTHH, TTHT,
TTTH, TTTT}

11. $\frac{2}{5}$ **13.** $\frac{1}{20}$

15. $\frac{3}{4}$ **17.** $\frac{1}{6}$

19. 0 **21.** $\frac{1}{36}$

23. $\frac{1}{4}$ **25.** $\frac{1}{4}$

27. $\frac{1}{2}$ **29.** $\frac{1}{2}$

31. 1 **33.** $\frac{1}{13}$

35. $\frac{1}{4}$ **37.** $\frac{1}{52}$

39. $\frac{2}{13}$

Writing & Thinking

41. Chance experiments include, but are not limited to, tossing a coin, spinning a bottle, drawing a card from a standard deck of cards, picking numbers in the lottery, choosing straws, and picking colored marbles.

43. Probabilities are between 0 and 1, inclusive. The sum of the probabilities of the outcomes in a sample space is 1. An event has probability 0 if it can never occur, such as rolling a 7 on a die. An event has probability 1 if it will always occur, such as rolling one of the numbers 1, 2, 3, 4, 5, or 6 on a die.

Chapter 4: Decimal Numbers

4.1 Exercises

Concept Check

1. and

3. two, eight hundredths

5. right

7. True

9. False; On a number line, any number to the right of another number is larger than that other number.

Practice

1. 6.5

3. 18.76

5. 56.03

7. 37.498

9. 87.003

11. Nine tenths

13. Twenty and seven tenths

15. One and fifty-three hundredths

17. Nineteen and one hundred two thousandths

19. Eight hundred and nine thousandths

21. 0.3 **23.** 7.9

25. 0.23 **27.** 6.028

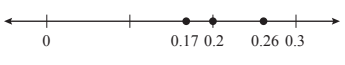
29. 0.4502 **31.** 0.27

33. 0.163 **35.** 24.295

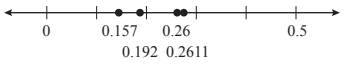
37. 0.01

39.

41.



43.



45. 7, 8, 8, 7, 8, 8, 34.8

47. 5, 2, 2, 5, 2, 3.0065

49. 8.6 **51.** 10.0
53. 1.68 **55.** 0.08
57. 0.057 **59.** 3.003
61. 4 **63.** 30
65. 5200 **67.** 400
69. 103,000 **71.** 51,000

Applications

73. One hundred fourteen and eight tenths
75. Nine-hundred fourteen thousandths; One and nine hundredths; Thirty-nine and thirty-seven hundredths; Three and thirty-seven hundredths.
77. Two and eight-hundred twenty-five ten-thousandths
79. Two and seventy-one thousand eight hundred twenty-eight hundred-thousandths
81. Nine and fifty-eight hundredths; Nineteen and nineteen hundredths; forty-three and three hundredths.
83. Thirty-five and eight tenths; Twenty-six and nine tenths; Eighteen and nine tenths; Twelve and three tenths; Seven and two tenths

Writing & Thinking

85. Answers will vary. Example: If the bill is $129, then that would be 129 and one hundred twenty-nine.
87. Moving left to right, compare digits with the same place value. When one compared digit is larger, the corresponding number is larger.

4.2 Exercises

Concept Check

1. vertically
3. whole
5. distributive
7. True
9. False; Once decimal points and corresponding digits have been aligned vertically, add or subtract from right to left.

Practice

1. 50.085 **3.** 237.74
5. 9.83 **7.** 72.31
9. 599.07 **11.** 156.305
13. 19.541 **15.** 40.313
17. 11.131 **19.** 17.8
21. 45.01 **23.** 4.7974
25. 8.93 **27.** 1.44
29. 0.9757 **31.** 17.5616
33. –13.15 **35.** –15.43
37. 3.3 **39.** 6.3
41. 5.8 **43.** 12.51
45. $-13.4x$ **47.** $45.5y$
49. $6.3t$
51. $10.3x - 4.1y$
53. $15.6x + 1.2$
55. $-1.069x - 5.71y$
57. 61.2 cm
59. 18.84 m

Applications

61. **a.** $94.85 **b.** $5.15
63. 82.83 feet
65. $671.75
67. **a.** 39.9 million
b. 31.9 million
69. **a.** 6.97 feet **b.** 2.73 feet
c. $502.35
71. **a.** 12.15 gallons
b. 3.25 gallons
73. $6089.90
75. 12.1778 tons
77. No, he is short $0.19.
79. **a.** 758.99909 sec
b. 761.00073 sec
81. 0.02458 liter
83. **a.** $67.22
b. 32.78

Writing & Thinking

85. Decimal numbers need to be aligned vertically so that numbers with the same place value are being added together. If not, then a 60 may be added to a 7 as if it were a 6 being added to a 7, giving 13, not the value of 67 that it should be.
87. **a.** Answers will vary.
b. Answers will vary.
89. Sophia did not align the decimal points in the addends vertically, so she was not adding corresponding place values.

4.3 Exercises

Concept Check

1. 5
3. 10
5. integers
7. False; The decimal points do not need to be aligned vertically when multiplying decimal numbers.
9. False; Multiplying by 100 requires that the decimal point be moved 2 places to the right.

Practice

1. 0.42 **3.** –0.75
5. 0.42 **7.** –0.112
9. 0.01096 **11.** 1.4000
13. –3.975 **15.** 1.200
17. 65.3980 **19.** 0.04336
21. –456 **23.** –275
25. 1610 **27.** –763.5
29. 61.5 **31.** –0.18
33. –0.08 **35.** 6.54
37. 20 **39.** 56.9
41. 0.7 **43.** 0.9
45. –728.7 **47.** 0.01
49. 5.78 **51.** 12.12
53. 0.56 **55.** 3.8
57. –0.785 **59.** –0.5036
61. –0.045621
63. 0.000154

Applications

65. 18.8 mm; 22.09 mm^2
67. $240.90
69. $936,945
71. $29,099.34
73. 19.2 millimeters
75. $239.56
77. $295
79. 5603 at bats
81. 4.4 yards per carry
83. 67.92

Writing & Thinking

85. In multiplication with decimal numbers, placement of the decimal point must be considered. Otherwise, multiplication with whole numbers and decimal numbers are the same.
87. To divide decimal numbers:
1. Move the decimal point in the divisor to the right so that the divisor is a whole number.
2. Move the decimal point in the dividend the same number of places to the right.
3. Place the decimal point in the quotient directly above the new decimal point in the dividend.
4. Divide just as with whole numbers.

4.4 Exercises

Concept Check

1. leftmost
3. decimal point
5. exponential expressions
7. False; When estimating the product of decimal numbers, round the

numbers to the leftmost nonzero digit.

9. True

Practice

1. 34; 32.82

3. 19; 21.79

5. 106; 102.46

7. 3; 3.31

9. 188; 207.45

11. 20; 26.08

13. 9; 8.92

15. 10; 9.09

17. 2.4; 2.621

19. 7000; 6548.06

21. 6; 4.86

23. 0.72; 0.7452

25. 6; 6.2144

27. 5; 5.17

29. 2; 2.032

31. 0.06; 0.0486

33. 5.4; 4.9077

35. 2; 2.05

37. 10; 9.45

39. 10,000; 9446.67

41. 2000; 2115

43. 75; 78.44 **45.** 3.5; 3.09

47. 0.2; 0.24 **49.** –14.75

51. 3.08 **53.** –12.22

55. 62.12 **57.** –7.56

59. 13.7 **61.** 14.31

63. –4.7 **65.** –10.56

67. 16.11

Applications

69. **a.** 39 pounds

b. 35.43 pounds

71. **a.** 15 feet **b.** 15.03 feet

73. **a.** $5000 **b.** $5959.80

75. **a.** $900 **b.** $891.50

c. $10,698.00

77. **a.** 600 miles **b.** 480.7

79. **a.** $4 per pound

b. $5.11 per pound

81. **a.** 15 mpg **b.** 22 mpg

83. **a.** $740 **b.** $772

Writing & Thinking

85. Answers will vary. The estimate says you are paying $4000 more with the payment plan than cash. This is a significant overestimate since the payment and the number of months were both rounded up.

4.5 Exercises

Concept Check

1. statistics

3. data

5. odd

7. True

9. False; The number that appears the greatest number of times in a set of data is the mode.

Practice

1. **a.** 58 **b.** 57 **c.** 57 **d.** 4

3. **a.** $48,625 **b.** $46,500

c. $63,000 **d.** $43,000

5. **a.** 83.8 **b.** 83.5 **c.** 82

d. 12

7. **a.** 17.6 in. **b.** 14.9 in.

c. None **d.** 19.7 in.

9. **a.** 96,360 m^3

b. 84,500 m^3

c. None **d.** 82,700 m^3

11. **a.** $4892.60 **b.** $5100

c. None **d.** $2890

13. **a.** 22.3 **b.** 21 **c.** 23

d. 19

15. **a.** 15.425 **b.** 14.5

c. 17 and 3 **d.** 44

17. **a.** 1135 miles

b. 980 miles

c. None **d.** 2020 miles

19. **a.** 12,371,400

b. 11,872,500

c. None **d.** 6,955,000

Application

21. 79

23. **a.** 3.48 million farms

b. 2.23 million farms

25. **a.** 734,616.7 **b.** 320,725

Writing & Thinking

27. The first step to finding the median is always to arrange the data in order. The median is the middle number. If there is an even number of item, average the two middle numbers to find the median.

29. Answers will vary. Examples include: median income or home value for a particular area, mean temperature at a certain level in the ocean, mode of days having a particular heat index in a particular geographic location, or the range of SAT or ACT scores for a graduating class.

Collaborative Learning

31. Answers will vary.

4.6 Exercises

Concept Check

1. numerator, denominator

3. repeating, nonrepeating

5. terminating

7. True

9. False; In some cases, fractions can be converted to decimal form without losing accuracy

Practice

1. $\frac{9}{10}$ **3.** $-\frac{57}{100}$

5. $\frac{16}{1000}$ **7.** $-\frac{72}{10}$

9. $-\frac{17}{100}$ **11.** $\frac{1}{8}$

13. $-\frac{7}{2}$ or $-3\frac{1}{2}$

15. $\frac{177}{100}$ or $1\frac{77}{100}$

17. 0.05 **19.** $-0.\overline{6}$

21. $-0.2\overline{7}$ **23.** $0.\overline{5}$

25. 6.67 **27.** –0.48

29. 0.03 **31.** –1.43

33. 1.64 **35.** 72.31

37. 1.13 **39.** –1

41. 0.09 **43.** –10.40

45. –120.31 **47.** 2.64

49. –17.55 **51.** –1.7

53. 0.878 is larger; 0.003

55. 3.3 is larger; $0.1\overline{571428}$

57. $3\frac{2}{3}$ is larger; $0.0\overline{16}$

59. $\frac{7}{10}, \frac{3}{4}, 0.76$

61. $\frac{5}{16}, 0.3126, 0.314$

63. 0

65. $-\frac{5}{9}$

67. $15\frac{5}{8}$

Applications

69. $93\frac{4}{5}$

71. $30\frac{3}{10}$; $28\frac{2}{5}$

73. $21\frac{1}{2}$

75. 0.58

77. 2.9

79. 17.92 inches

81. 20.2 miles

83. 60 students that drive to school and have a job at Summerville High School are taking AP English

85. 0.9 ounces

87. 25 slides

Writing & Thinking

89. For the numerator, write the whole number formed by all the digits of the decimal number, and for the denominator, write

the power of 10 that corresponds to the rightmost digit. Reduce the fraction, if possible.

91. This problem could be solved by converting all numbers to fractions or all numbers to decimal numbers. Answers will vary.

4.7 Exercises

Concept Check

1. +1

3. variables, constants

5. False; When an equation is solved, the variable can be on the left side or the right side.

Practice

1. $x = -107.3$

3. $y = -17$

5. $x = 31$

7. $x = 74.1$

9. $x = -3.31$

11. $y = 81.2$

13. $y = 165.9$

15. $t = -10.3$

17. $t = 2503$

19. $x = 4.04$

21. $x = -32.85$

23. $y = 11.44$

25. $z = -4.16\overline{6}$

27. $z = -2.038$

29. $x = 0$

31. $x = -0.5$

33. $x = 5.2$

35. $x = 2.1$

37. $x = 3.48$

39. $x = 0.5$

41. $x = 31$

43. $x = -1.3$

45. $x = 2.3$

47. $z = 0$

Applications

49. \$55.45 (video game); \$17.30 (game guide)

51. $x = -13.1$

53. 240 miles

Writing & Thinking

55. a. To isolate the variable on one side of the equation with a coefficient of 1; Answers will vary.

b. They allow you to move terms from one side of an equation to the other side to get variables terms on one side of the equation and constants on the other side; Answers will vary.

c. They allow you to manipulate the coefficients of the variable term to get a coefficient of 1 on the variable term; Answers will vary.

Chapter 5: Percents

5.1 Exercises

Concept Check

1. 100

3. two; left

5. reduced or simplified

7. False; It is possible to have a percent greater than 100%.

9. False; To change from a percent to a decimal, move the decimal point two places to the left and omit the percent sign.

Practice

1. 60%

3. 72%

5. 20%

7. 125%

9. 0.5%

11. 2.14%

13. 2%

15. 10%

17. 36%

19. 12.8%

21. 112%

23. 200%

25. 0.02

27. 0.18

29. 0.6

31. 1.25

33. 0.173

35. 0.0026

37. 7%

39. 50%

41. 55%

43. 87.5% or $87\frac{1}{2}\%$

45. 12.5% or $12\frac{1}{2}\%$

47. 125%

49. 210%

51. 206.7% or $206\frac{2}{3}\%$

53. $\frac{1}{25}$

55. $\frac{1}{4}$

57. 1

59. $1\frac{1}{2}$

61. $\frac{3}{400}$

63. $\frac{1}{200}$

65. $\frac{1}{8}$

67. $\frac{1}{6}$

69. a. 0.625 **b.** 62.5%

71. a. $\frac{9}{100}$ **b.** 9%

73. a. $\frac{9}{25}$ **b.** 0.36

Applications

75. 28%

77. 4%

79. 0.085

81. 0.45

83. 5.23

85. $\frac{3}{10}$

87. $3\frac{17}{20}$

89. a. $8\frac{1}{3}\%$ **b.** 25%

c. $6\frac{1}{4}\%$ or 6.25%

91. 85%

93. a. 0.0011 **b.** 0.11%

c. Yes

95. 9.8%

Writing & Thinking

97. Sometimes it is possible to have percentages over 100%. For example, if a bank account had \$50 and someone put in \$75, the amount deposited would have been 150% (starting \$50 + \$25 more) of the original amount. However, sometimes more than 100% is not possible. For example, if a gas tank can hold exactly 16 gallons of gas, 110% of the capacity could not be put into the tank.

99. 100% = 1 so anytime there is a mixed number, which has a value greater than 1, the percentage will be greater than 100%. Proper fractions (numerator is smaller than denominator) have a value less than 1 and therefore the percentage will be less than 100%.

5.2 Exercises

Concept Check

1. percent, 100

3. 172.3

5. $\frac{95}{100} = \frac{A}{60}$

7. False; In the proportion $\frac{P}{100} = \frac{63}{180}$, the base is 200.

9. False; The base is not always larger than the amount.

Practice

1. 7.5

3. 15

5. 64

7. 47

9. 900

11. 150

13. 62

15. 20%

17. 150%

19. 150

21. 30 **23.** 24
25. 33.3% **27.** 40
29. 70 **31.** 230
33. 3.6 **35.** 17.5
37. 512 **39.** 65
41. 81 **43.** 66.5%
45. 12.82 **47.** 125%
49. 33.6 **51.** 105
53. 115.61 **55.** 400
57. 200 **59.** 28
61. 120

Applications

63. 56,000 fans
65. 47.31%
67. $97,600
69. **a.** 93.75%
b. 6.25%; Keep this player
71. 27 aces
73. Army: 13.44%;
Marine Corps: 6.66%;
Navy: 15.90%;
Air Force: 19.21%;
Coast Guard: 16.43%

Writing & Thinking

75. Proportions would work for mixed numbers because a mixed number can be rewritten as a fraction. The only additional step required would be to change the mixed number to an improper fraction and then solve the proportion as normal.

5.3 Exercises

Concept Check

1. base
3. multiplication or times
5. amount, A
7. True
9. True

Practice

1. 7 **3.** 3.1
5. 9 **7.** 42
9. 150 **11.** 20%
13. 150 **15.** 50
17. 70 **19.** 36
21. 33.3% **23.** 35%
25. 12.5 **27.** 18
29. 110 **31.** 180%
33. 614 **35.** 38
37. 80 **39.** 200%
41. 75 **43.** 16.32
45. 58.5 **47.** 11.4
49. 24 **51.** 72
53. 95% **55.** 29%
57. 175% **59.** 72
61. 16 **63.** 10
65. 25 **67.** 28
69. 165.6

Applications

71. 6800 **73.** 4.8%
75. 34.29 g **77.** 40
79. **a.** 61.728% **b.** 56.790%
c. 57.407% **d.** 49.383%
e. 58.642% **f.** 55.556%
g. 54.658% **h.** 50.617%
i. 58.642% **j.** 55.556%
k. 66.049% **l.** 65.432%

Writing & Thinking

81. The three parts are the rate, base, and amount. The rate is the percent but should be written in decimal number form. The amount is the number that is part of the whole and the base is the whole.

83. The amount is the number that is often near the word "is." The base is the number that often follows the word "of." The rate is the number written either as a fraction or as a decimal number that has not been identified as the amount or the base, and usually appears before the word "of."

5.4 Exercises

Concept Check

1. look back or check
3. (total) sale or selling
5. appreciation
7. True **9.** True

Applications

1. **a.** $30 **b.** $270
3. **a.** $465 **b.** $15,035
5. $16.88; $5.63
7. $61.25
9. **a.** $161 **b.** $5474
11. $52
13. **a.** $6.93 **b.** $122.38
15. 1.5%
17. **a.** $250 **b.** 20%
c. $216
19. $11,700 **21.** $875
23. $28,000 **25.** $770
27. $1315 **29.** $112,700
31. $10,000 **33.** 5.9%
35. 2.484%
37. 82,286 people
39. **a.**$50.00 **b.** 5.56%
41. 38%
43. **a.** $7 **b.** $33\frac{1}{3}\%$
c. 25%
45. **a.** $180 **b.** 40%
c. $28\frac{4}{7}\%$ or 28.6%
47. **a.** $500 **b.** 25% **c.** 20%
49. **a.** $1075 **b.** $258
c. 24% **d.** 30%
51. $1.89
53. $1.39; $1.75
55. $8.64
57. $31.80
59. **a.** $3.60 **b.** $22.50
61. $111.60

Writing & Thinking

63. Sales tax and tips are percentages of some item or service. The percent is the rate, while the cost of the item being purchased is the base. The amount is then the sales tax itself, which is being compared to the base. A sales tax might be 8%, as in "what is 8% of the cost of the item purchased?"

65. For both types of percent of profit, the profit (the difference between selling price and cost) must be determined first. The profit is then used as a numerator. In profit based on cost, the denominator is the cost. In profit based on selling price, the selling price is the denominator. The fraction is then divided and the result is a percent of profit, either based on cost or selling price.

5.5 Exercises

Concept Check

1. interest
3. simple
5. quarterly
7. True
9. False; Compound interest is earned on the principal and interest earned.

Applications

1. $30 **3.** $32
5. $200 **7.** $100
9. $37.50 **11.** $2500
13. $3000 **15.** 1 year
17. 72 days **19.** $9
21. $3.33 **23.** 10%
25. $1030 **27.** $730
29. $337,500
31. **a.** $1000
b. 9 months or $\frac{3}{4}$ year
33. $1030
35. 240 days or $\frac{2}{3}$ year
37. **a.** $16 **b.** $100
c. 30 days or $\frac{1}{12}$ year
d. 8.5%
39. **a.** $100 **b.** $2100, $105
c. $2205, $110.25
d. $315.25

41. **a.** $30

b. $9030, $30.10

c. $9060.10, $30.20

d. $9090.30, $30.30

e. $120.60

f. $9120.60

43. $509.58

45. $9090.30

47. $189.24

49. **a.** $1051.56 **b.** $51.56

51. **a.** $28,051.03

b. $329.40

53. **a.** $634.13 **b.** No

c. Monthly compounding allows interest earned the previous month to gain interest the following month, but semiannual compounding waits six months for this process to begin.

55. **a.** $1493.42 **b.** $93.42

57. **a.** $67,952.39 **b.** More

c. $184,675.81

59. **a.** $1645.31 **b.** 645.31

61. **a.** $10,560.33

b. $5560.33

63. **a.** $275,470.73

b. $250,470.73

65. Milk: $4.01; Bread: $3.35

67. $12,665.57

69. 11.4%

71. $8541.94

Writing & Thinking

73. The simple interest formula is $I = P \cdot r \cdot t$ where I is interest, P is principal, r is rate, and t is time. Interest is the amount of money paid for the use of money. The principal is the starting amount invested. Rate is the interest rate and should be written as a decimal or fraction. Time is the amount of time, in years, that interest is being earned on the principal. Time can be written as a decimal or fraction. When a decimal is used, it should only be when it is a terminating decimal so that no rounding is required, which could change the value calculated.

75. Answers will vary.

a. $13,498.03

b. About 7 years.

Collaborative Learning

77. **a.**

Monthly Income	4%	6%	8%
$2000	$2433.31	$2676.45	$2938.66
$2500	$3041.63	$3345.56	$3673.32
$4000	$4866.61	$5352.90	$5877.31

b. Answers will vary. The total increase in income after 5 years is similar for the lower income with an 8% yearly pay raise and the higher income with the 4% yearly pay raise.

c. Answers will vary.

5.6 Exercises

Concept Check

1. graphs **3.** circle

5. upper **7.** True

9. True

Applications

1. **a.** Social Science

b. Chemistry & Physics, Humanities

c. About 3300

d. About 21.2%

3. **a.** Sue **b.** Bob and Sue

c. 85.7%

d. Bob and Sue, Bob and Sue, Yes, in most cases

e. No, the vertical scales represent two different types of quantities

5. **a.** News: 300 min; Movies: 120 min; Sitcoms: 156 min; Soaps: 180 min; Drama: 144 min; Children's shows: 120 min; Commercials: 180 min

b. News **c.** 480 min

7. **a.** Taxes **b.** 25% **c.** 1:2

9. **a.** February and May

b. 6 inches **c.** March

d. 3.58 inches

11. **a.** August **b.** 4

c. April, May, July, August

d. 1 **e.** 14% **f.** 13%

13. **a.** West: 5%; Northeast: 28%; Midwest: 35%; South: 32%

b. West: 22%; Northeast: 19%; Midwest: 23%; South: 36%

c. South **d.** 5%

e. West **f.** 5%, 1900

g. 36%, 2000

h. Midwest

15. **a.** 8 **b.** 3 **c.** Eight class

d. 2 **e.** 27, 29 **f.** 50

g. 10 **h.** 16%

Writing & Thinking

17. The four types of graphs are **1.** bar graphs, used for comparative amounts; **2.** circle graphs, also known as pie charts, to help understand percents or parts of a whole; **3.** line graphs, to indicate tendencies or trends over time; and **4.** histograms to indicate data in a range or interval of numbers (called classes).

19. Both bar graphs and histograms use bars to indicate information. A bar graph uses categories and has spaces between the bars to separate the categories. A histogram uses boundaries of intervals instead of categories and the bars have no space between the classes.

Chapter 6: Measurement and Geometry

6.1 Exercises

Concept Check

1. pint, 16 **3.** yard

5. converted **7.** True

9. True

Practice

1. 12 **3.** 1

5. 1 **7.** 5280

9. 1 **11.** 8

13. 36 **15.** 300

17. 2 **19.** 21

21. 2 **23.** 1.5

25. $\frac{3 \text{ ft}}{1 \text{ yd}}$; 21

27. $\frac{1 \text{ qt}}{2 \text{ pt}}$; 3

29. $\frac{1 \text{ gal}}{4 \text{ qt}}$; 3.25

31. $\frac{1 \text{ ft}}{12 \text{ in.}}$; 1.5

33. $\frac{5280 \text{ ft}}{1 \text{ mi}}$; 15,840

35. $\frac{1 \text{ mi}}{5280 \text{ ft}}$; 1.5

37. 8 **39.** 32,000

41. 4 **43.** 88

45. 1.5 **47.** 150

Applications

49. $\frac{7}{8}$ or 0.875 square feet

51. $93.22

53. $\frac{1}{2}$ or 0.5 miles

55. 15 miles per hour

57. The small bag; $0.005¢/oz

59. 126,720 inches

61. $65

63. 5

Writing & Thinking

65. Colby would need to know that there are 3 feet in a yard and 5280 feet in a mile.

67. A unit fraction is a fraction with different units that is equivalent to 1. It can be used to convert between units. When used, the numerator should contain the same units as the desired outcome and the denominator should have the same unit as the unit being converted.

6.2 Exercises

Concept Check

1. threes **3.** meter

5. multiply **7.** True

Practice

1.–9. Answers will vary.

11. Meters **13.** Meters

15. Millimeters

17. 300 **19.** 80

21. 1500 **23.** 3.6

25. 0.82 **27.** 0.0525

29. 0.75 **31.** 0.245 m

33. 0.23 m **35.** 10 km

37. 200 m **39.** 0.00679 km

41. 150.3 **43.** 30 000 000

45. 960 **47.** 5

49. 500 000

51. 1300; 130 000

53. 115 000; 11 500 000

55. 400; 40 000

57. 670 **59.** 20 000

61. 575 ha **63.** 956; 95 600

65. 0.0625; 0.000625

Applications

67. 3.2 cm^2

69. 50 mm

71. 44 000 square meters

73. 6 gigahertz

75. 500 gigabytes

77. 75 hectares

79. 70 000 square meters

Writing & Thinking

81. Converting among the U.S. customary systems requires knowledge of the equivalencies and there is no consistency among them so they must be memorized. Within the metric system, typically all that is required for conversions is to simply move the decimal point the desired number of places according to the prefixes.

83. Each category of metric units has a base unit. The prefixes determine how many or what fraction of the base unit is being used. For example, the basic unit of length is meter and a millimeter is 1/1000 of a meter, a centimeter is 1/100 of a meter, and a kilometer is 1000 meters.

6.3 Exercises

Concept Check

1. cubic

3. weight

5. kilogram

7. False; Volume is measured in cubic units.

9. False; A metric ton and a US customary ton are not equal (a metric weighs about 2200 US pounds).

Practice

1. Milliliters **3.** Liters

5. Milliliters **7.** 2000

9. 0.019 **11.** 13 000

13. 0.5 **15.** 6300

17. 0.0764 **19.** 0.95

21. 1250 **23.** 5300 mL

25. Kilograms

27. Grams

29. Milligrams

31. 2000 **33.** 7580

35. 540 **37.** 2

39. 0.0345 **41.** 0.091

43. 4 600 000

45. 2.963 **47.** 5000 kg

49. 96 000 mg

51. 75 kg **53.** 0.0016 g

55. 0.000 34 kg

57. 7 000 000 g

59. m **61.** L

63. km **65.** L

67. g **69.** 0.006

71. 0.4

73. 9 000 000 cm^3

Applications

75. 60 doses

77. Yes. The total amount of solution to be disposed is 3.7 L.

79. 60 000 000 000 grains

81. 57.8 L

Writing & Thinking

83. You could change to milliliters by multiplying by 1000 or by using a unit fraction where the numerator is 1000 mL and the denominator is the given measure in liters.

85. You would probably use kilograms because a gram is approximately the weight of a paperclip and a kilogram is about 2.2 pounds.

6.4 Exercises

Concept Check

1. Fahrenheit

3. 2.54

5. 0.946

7. False; Water freezes at 32 degrees Fahrenheit.

9. False; A 5K (km) run is shorter than a 5 mile run.

Practice

1. 77 **3.** 50

5. 45 **7.** 122

9. 0 °C **11.** 59 °F

13. 2.74 **15.** 11.99

17. 83.82 **19.** 27.88

21. 32.19 **23.** 2.74 m

25. 96.6 km **27.** 124.22 mi

29. 19.69 in. **31.** 35.56 cm

33. 19.35 **35.** 55.74

37. 83.61 **39.** 405

41. 741.32 acres

43. 53.82 ft^2 **45.** 4.65 $in.^2$

47. 3.79 **49.** 1.06

51. 9.46 **53.** 78

55. 11.10 **57.** 10.57 qt

59. 189.25 L **61.** 72.75

63. 992.23 **65.** 4.56

67. 3.53 **69.** 453.59 g

71. 264.55 lb

Applications

73. 177 °C

75. 9.7 miles per hour

77. 226.3 km

79. 3035.14 m^2

81. **a.** 11 145.6 cm^2

b. 1.116 m^2

83. 7 cans

85. Answers will vary.
Small: 5.4 ounces;
Medium: 10.8 ounces or 10.9 ounces;
Large: 1 pound 5 ounces or (21 ounces)

87. 2.7 mL

Writing & Thinking

89. One meter is equivalent to 1.09 yards so they are close in length.

91. Because conversions between the metric system and the US system require rounding, it is possible that two answers could be right although they might be slightly different. If Kai used the US to Metric equivalent and Kristen used the Metric to US equivalent, they would both have a correct answer but their answers will be slightly different answers because they used different approximations.

6.5 Exercises

Concept Check

1. line

3. vertex

5. straight

7. perpendicular

9. equilateral

11. True

13. True

15. True

Practice

1. 35°

3. 80°

5. Acute

7. Obtuse

9. Acute

11. **a.** Obtuse **b.** Acute

c. Right

13. **a.** 180° **b.** 90° **c.** 30°

d. 150°

15. **a.** 135° **b.** 90° **c.** 70°

d. 45°

17. **a.** 150°

b. Yes; $\angle 2$ and $\angle 3$ are supplementary.

c. $\angle 1$ and $\angle 3$; $\angle 2$ and $\angle 4$

d. $\angle 1$ and $\angle 2$; $\angle 2$ and $\angle 3$; $\angle 3$ and $\angle 4$; $\angle 1$ and $\angle 4$

19. $m\angle 2 = 138°$;
$m\angle 3 = 42°$
$m\angle 4 = 138°$

21. **a.** $m\angle 2 = 70°$;
$m\angle 3 = 90°$;
$m\angle 4 = 20°$;
$m\angle 5 = 70°$

b. $\angle 3$ **c.** $\angle 2$ and $\angle 5$

23. **a.** 125°; $\angle 1$ and $\angle 3$ are vertical angles.

b. 55°; $\angle 8$ and $\angle 6$ are vertical angles.

c. $m\angle 7 = 125°$; $\angle 6$ and $\angle 7$ are supplementary angles.

d. Yes; $\angle 2$ and $\angle 6$ are corresponding angles.

25. Scalene

27. Right

29. Isosceles

31. Isosceles and right

33. Acute

35. Acute

Applications

37. Yes, since $25 < 12 + 15$.

39. **a.** $m\angle Z = 80°$ **b.** Acute

c. $\overline{YZ}$ **d.** $\overline{XZ}$ and $\overline{XY}$

e. No, no angle is 90°

Writing & Thinking

41. A ray is similar to a line in that it has at least one end that continues infinitely. An angle is formed by two rays that have a common endpoint, called a vertex. A line has no endpoint and continues indefinitely in opposite directions in the same plane.

43. **a.** A right angle

b. An acute angle

c. An obtuse angle

6.6 Exercises

Concept Check

1. polygon

3. rectangle

5. radius

7. **a.** True

b. False; Not all rectangles have four equal sides.

9. True

11. **a.** F **b.** C **c.** A **d.** E

e. D **f.** B

Practice

1. 44 cm **3.** 116 cm

5. 18 km **7.** 143 in.

9. 48.1 yd **11.** 3.14 m

13. 188.4 cm **15.** 40 cm

17. 45 cm **19.** 34 cm

21. 200 yd **23.** 36 cm

25. 35 ft **27.** 43 cm

29. 36 m **31.** 40 ft

33. 50 in. **35.** 108 ft

37. 25.12 m **39.** 8.792 yd

41. 35.98 in. **43.** 21.42 m

45. 19.42 cm **47.** 20.13 yd

Applications

49. 114 cm

51. 38.4 in.

53. **a.** 4605 ft
b. 15.7 minutes

55. **a.** 548 ft **b.** \$8220

57. $13\frac{4}{5}$ inches

Writing & Thinking

59. Some of the polygons are: triangle (3 sides), square (4 sides), rectangle (4 sides), parallelogram (4 sides), and trapezoid (4 sides).

61. Perimeter is the distance around a figure. Formulas for the perimeter of: triangle $(P = a + b + c)$, square $(P = 4s)$, rectangle $(P = 2l + 2w)$, trapezoid $(P = a + b + c + d)$, and parallelogram $(P = 2a + 2b)$.

6.7 Exercises

Concept Check

1. square

3. parallelogram

5. square

7. False; The $(b + c)$ in the trapezoid area formula represents the sum of the lengths of the two parallel bases.

9. False; The area formula for a triangle is $A = \frac{1}{2}bh$.

Practice

1. 81 ft^2 **3.** 525 km^2

5. 27.37 ft^2 **7.** $\frac{5}{27}$ $in.^2$

9. 165 cm^2 **11.** 1.76625 ft^2

13. 48 $in.^2$ **15.** 99 ft^2

17. 162 yd^2 **19.** 1925 cm^2

21. 196 $in.^2$ **23.** 48 cm^2

25. 160 $in.^2$ **27.** 75.3914 m^2

29. 60 $in.^2$ **31.** 38.88 m^2

33. 26.13 cm^2

35. 11.14 m^2 **37.** 107 m^2

39. 99 $in.^2$ **41.** 220 mm^2

43. 36 cm^2 **45.** 7536 m^2

47. 192 m^2 **49.** 99 $in.^2$

51. **a.** 12 ft; 6 ft^2

b. 30 cm; 30 cm^2

c. 48 in.; 96 $in.^2$

53. **a.** 70 cm **b.** 220 cm^2

55. **a.** 30 m **b.** 24 m^2

57. **a.** 157 ft **b.** 1962.5 ft^2

Applications

59. 204 square feet

61. **a.** 30 ft^2 **b.** 30 ft

63. **a.** 75 cm **b.** 336 cm^2

65. **a.** 2350 square feet

b. 11.75 pounds

67. 123 square feet

69. 314.96 $in.^2$

71. 91.74 square feet

73. 426 square meters

Writing & Thinking

75. Examples will vary. Area is required when purchasing carpet, laying sod, putting on a roof, painting walls, building a deck, and with construction projects in general.

77. The result should be close to π in each case. $\frac{C}{d} = \pi$

6.8 Exercises

Concept Check

1. volume

3. surface area

5. right circular cylinder

7. True

9. True

11. **a.** C **b.** E **c.** D **d.** B **e.** A

Practice

1. 70 $in.^3$

3. 381.51 cm^3

5. 12.56 mm^3

7. 60 $in.^3$

9. 14.13 ft^3

11. 401.92 m^3

13. 376.8 ft^3

15. 2289.06 cm^3

17. 224 cm^3

19. 113.04 $in.^3$

21. 9106 dm^3

23. 56.52 ft^3

25. 1017.36 mm^2

27. 122 $in.^2$

29. 226.08 m^2

31. $V = 70$ $in.^3$; $V = 1147.09$ cm^3

33. $V = 12.56$ dm^3; $V = 0.012\,56$ m^3

Applications

35. 2,596,902 m^3

37. 10.39 $in.^3$

39. 800 ft^3

41. 13 cm

43. **a.** 3.375 ft^3 **b.** 13.5 ft^2

45. 1536 square inches

Writing & Thinking

47. Volume is measured in cubic units. Volume takes up a three-dimensional space and the units can be thought of as small cubes which leads to the concept of cubic units.

49. Volume is more important because it determines how many packages or what sized packages the driver can fit into the truck. Three-dimensional space (volume) is more important for this job.

6.9 Exercises

Concept Check

1. shape

3. proportional

5. False; Similar triangles have corresponding sides that are proportional.

7. False; If $\Delta ABC \cong \Delta DEF$ then $AC = DF$.

Practice

1. The triangles are not similar. The corresponding sides are not proportional.

3. $\Delta PQR \sim \Delta SUT$ All pairs of corresponding sides are proportional to the ratio 1:2.

5. $\Delta ABC \sim \Delta EDC$ The corresponding angles have the same measure.

7. $x = 50°$; $y = 70°$

9. $x = 50°$; $y = 50°$

11. $x = 20°$; $y = 100°$

13. $x = 4.8$; $y = 7.2$

15. $x = 7.5$; $y = 15$

17. $x = 6$; $y = 4$

19. $x = 95°$; $y = 20$

21. $x = 25°$; $y = 20°$

23. $x = 25°$; $y = 40°$

25. $x = 12$; $y = 10$

27. $x = 4.8$; $y = 2.5$

29. Congruent by SAS

31. Congruent by ASA

33. Not congruent

35. Congruent by SSS

Applications

37. 7.5 feet

39. 125 yd

41. 480 ft

43. 48 ft

45. 6.9 ft

Writing & Thinking

47. **a.** The triangles are similar since the three pairs of corresponding angles are congruent.

b. $m\angle A = m\angle D$, $m\angle B = m\angle E$, $m\angle C = m\angle F$

49. She needs to calculate the ratios of each pair of corresponding sides. Answers will vary.

6.10 Exercises

Concept Check

1. radical, radical

3. radicand

5. right

7. True

9. True

Practice

1. Yes, $16 = 4^2$

3. Not a perfect square

5. Yes, $400 = 20^2$

7. Yes, $121 = 11^2$

9. 144 **11.** 400

13. 6 **15.** 13

17. 15 **19.** 40

21. 16 **23.** 206

25. 3.4641 **27.** 6.9282

29. 4.3589 **31.** 16.9706

33. 0.9 **35.** 1.9

37. 1.23 **39.** 3.01

41. 0.03 **43.** 0.0548

45. **a.** Answers will vary. $\sqrt{39} > \sqrt{36} = 6$, so $\sqrt{39} > 6$

b. Answers will vary. $\sqrt{39} < \sqrt{49} = 7$, so $\sqrt{39} < 7$

47. **a.** 9 and 10 **b.** 9.7468

49. **a.** 3 and 4 **b.** 3.6056

51. **a.** 7 and 8 **b.** 7.0711

53. Yes, $6^2 + 8^2 = 10^2$

55. No, $3^2 + 4^2 \neq 6^2$

57. Yes, $5^2 + 12^2 = 13^2$

59. $c = 2.23$

61. $c = 5$

63. $c = 20.62$

65. $c = 14.14$ cm

67. $x = 6$ cm

69. $x = 13.42$ ft

71. 10 ft; 18.47 ft

73. **a.** 94.2 ft **b.** 706.5 ft^2 **c.** 84.85 ft **d.** 450 ft^2 **e.** 256.5 ft^2

Applications

75. 2.24 miles

77. 8.559 feet long

79. 22.4 meters

81. **a.** 126.3 feet

b. Closer to home plate

83. 44.9 inches

85. 17.0 inches

87. 14.2 km

Writing & Thinking

89. The radical sign is $\sqrt{\ }$. The radicand is the number under the radical sign. A radical expression includes the radical sign and its radicand. For example, in the expression $\sqrt{36}$ the entire expression is called a radical expression, 36 is the radicand, and the symbol $\sqrt{\ }$ is called the radical sign.

91.

m	n	$a = 2nm$	$b = m^2 - n^2$	$c = m^2 + n^2$	Pythagorean Triple?
5	1	10	24	26	Yes: $10^2 + 24^2 = 26^2$
7	1	14	48	50	Yes: $14^2 + 48^2 = 50^2$
3	2	12	5	13	Yes: $12^2 + 5^2 = 13^2$
7	2	28	45	53	Yes: $28^2 + 45^2 = 53^2$
5	3	30	16	34	Yes: $30^2 + 16^2 = 34^2$
11	3	66	112	130	Yes: $66^2 + 112^2 = 130^2$
13	7	182	120	218	Yes: $182^2 + 120^2 = 218^2$

Chapter 7: Solving Linear Equations and Inequalities

7.1 Exercises

Concept Check

1. reciprocal

3. zero-factor

5. opposite

7. False; The commutative property of addition allows the order to change.

9. False; The additive identity of all numbers is 0.

Practice

1. $3 + 7$

3. $4 \cdot 19$

5. $30 + 48$

7. $(2 \cdot 3) \cdot x$

9. $(3 + x) + 7$

11. 0

13. $x + 7$

15. $2x - 24$

17. 0

19. Commutative property of addition

21. Multiplicative identity

23. Associative property of addition

25. Commutative property of multiplication

27. Commutative property of multiplication

29. Multiplicative inverse

31. Additive inverse

33. Multiplicative identity

35. Zero-factor law

37. Associative property of addition

39. $6(11) = 66$ and $6 \cdot 3 + 6 \cdot 8 = 66$

41. $10(-7) = -70$ and $10 \cdot 2 - 10 \cdot 9 = -70$

43. Commutative property of multiplication; $6 \cdot 4 = 4 \cdot 6 = 24$

45. Associative property of addition; $8 + (5 + (-2)) = (8 + 5) + (-2) = 11$

47. Distributive property; $5(4 + 18) = 5(4) + 90 = 110$

49. Associative property of multiplication; $(6 \cdot (-2)) \cdot 9 = 6 \cdot (-2 \cdot 9) = -108$

51. Commutative property of addition; $3 + (-34) = (-34) + 3 = -31$

53. Commutative property of addition; $2(3 + 4) = 2(4 + 3) = 14$

55. Commutative property of addition; $5 + (4 - 15) = (4 - 15) + 5 = -6$

57. Associative property of multiplication; $(3 \cdot 4) \cdot 5 = 3 \cdot (4 \cdot 5) = 60$

Applications

59. **a.** \$118.25

b. $\$11 \cdot \left(6\frac{1}{2}\right) + \$11 \cdot \left(4\frac{1}{4}\right)$

c. Distributive property

61. **a.** \$85.04 – \$28.79 – \$50.00 – \$12.16 or \$85.04 – (\$28.79 + \$50.0 + \$12.16)

b. –\$5.91

c. –\$5.91 + \$5.91 = 0

d. The additive inverse property

7.2 Exercises

Concept Check

1. equation

3. addition, equality

5. dividing

7. True

9. True

Practice

1. $x = -2$ is a solution

3. $x = 4$ is not a solution

5. $x = -4$ is a solution

7. $x = -18$ is a solution

9. $x = -28$ is a solution

11. $x = 7$ **13.** $y = -4$

15. $x = -19$ **17.** $n = 37$

19. $z = -6$ **21.** $x = 5$

23. $y = -5.9$ **25.** $x = -1.2$

27. $x = \frac{11}{20}$ **29.** $x = 9$

31. $y = 8$ **33.** $x = 20$

35. $y = 10$ **37.** $x = -8$

39. $x = 12$ **41.** $n = 8$

43. $y = 2.1$ **45.** $x = \frac{20}{9}$

47. $x = -13.3$ **49.** $y = -12$

51. $x = -\frac{2}{5}$ **53.** $x = -4$

55. $x = \frac{5}{8}$ **57.** $n = 9.7$

59. $x = -4$ **61.** $y = -50.753$

63. $x = -17.214$

65. $x = 246$

67. $x = -153.17$

Applications

69. 1945 *kanji* characters

71. **a.** Answers will vary.
b. $x = 12.5$
c. The garden should be 12.5 feet wide.

73. 4.24 light years

75. 11,500 words

77. 2250 students

79. **a.** Answers will vary.
b. $x = 11{,}550$
c. Clara will need a loan for \$11,550.

Writing & Thinking

81. **a.** Yes. It is stating that $6 + 3$ is equal to 9.

b. No. If we substitute 4 for x, we get the statement $9 = 10$, which is not true.

7.3 Exercises

Concept Check

1. like

3. multiplication

5. substituting

7. False; Subtract 3 from both sides.

9. True

Practice

1. $x = -3$ **3.** $x = 2$

5. $x = 2$ **7.** $x = 2$

9. $y = -1$ **11.** $t = -1$

13. $x = -0.12$ **15.** $x = 4$

17. $x = 0$ **19.** $y = 0$

21. $x = -2$ **23.** $y = -6$

25. $n = 6$ **27.** $n = 8$

29. $x = 0$ **31.** $x = -7$

33. $x = -\frac{1}{8}$ **35.** $x = -\frac{13}{2}$

37. $x = -\frac{21}{5}$ **39.** $x = -\frac{8}{15}$

41. $y = \frac{28}{5}$ **43.** $x = 2$

45. $y = \frac{7}{5}$ **47.** $x = -4.5$

49. $x = -44$ **51.** $x = 2$

53. $x = -4$ **55.** $y = 0.5$

57. $x = 1.5$ **59.** $x = 0.2$

61. $x = 6.1$ **63.** $x = 1.12$

Applications

65. 14,000 tickets per hour

67. 52 pages

69. 240 cookies of each remaining variety

71. 135 yards

73. 379.7 feet

75. **a.** Lowest temperature; Change in temperature per hour; Current temperature

b. $x = 4$

c. The low temperature occurred 4 hours ago.

Writing & Thinking

77. **a.** The 4 should have been multiplied by 3 so that the 3 was distributed over the entire left-hand side of the equation; Correct answer is $x = 15$.

b. 3 should be subtracted from each side, not from each term, and $5x - 3$ doesn't simplify to $2x$; Correct answer is $x = \frac{8}{5}$.

7.4 Exercises

Concept Check

1. identity

3. conditional

5. real, $\mathbb{R}$

7. True

9. True

Practice

1. $x = -5$ **3.** $n = 3$

5. $y = 6$ **7.** $x = 3$

9. $n = 0$ **11.** $y = 0$

13. $z = -1$ **15.** $y = \frac{1}{5}$

17. $x = -3$ **19.** $x = -4$

21. $x = -21$ **23.** $y = 0$

25. $y = 1$ **27.** $x = -\frac{3}{2}$

29. $x = \frac{1}{4}$ **31.** $x = \frac{3}{17}$

33. $x = -\frac{1}{4}$ **35.** $x = \frac{8}{5}$

37. $x = \frac{2}{3}$ **39.** $x = 6$

41. $x = -11$ **43.** $x = \frac{1}{2}$

45. $x = -5$ **47.** $n = -1.5$

49. $x = 0$ **51.** Conditional

53. Conditional

55. Contradiction

57. Identity

59. Conditional

61. $x = -50.21$

63. $x = 1.067$

Applications

65. 20 guests

67. 0.34 hours

69. **a.** The area of the first flyer

b. The width of the second flyer

c. $x = 5$

d. Solution should be correct if part c. is correct.

e. The first flyer has a width of 5 inches.

71. 1800 square feet

73. 240 sundaes

Writing & Thinking

75. **a.** $5x + 1$ **b.** $x = 6$

c. Answers will vary.

7.5 Exercises

Concept Check

1. mathematically

3. time

5. substitute

7. False; Case matters in formulas

9. True

Applications

1. \$192

3. \$10,000

5. **a.** \$183.75 **b.** \$3683.75

7. 2 seconds

9. 4 milliliters

11. \$1030

13. 14 rafters

15. 336 in. or 28 ft

17. \$1030

19. 230 calculators

21. \$5 million

23. \$2400

25. 7 hours

27. 1.625 mph

29. $b = P - a - c$

31. $m = \frac{F}{a}$

33. $w = \frac{A}{l}$

35. $n = \frac{R}{p}$

37. $P = A - I$

39. $m = 2A - n$

41. $t = \frac{I}{Pr}$

43. $b = \frac{P - a}{2}$

45. $\beta = 180° - \alpha - \gamma$

47. $h = \frac{V}{lw}$

49. $b = \frac{2A}{h}$

51. $h = \frac{V}{\pi r^2}$

53. $g = \frac{mv^2}{2K}$

55. $y = \frac{6 - 2x}{3}$

57. $x = \frac{11 - 2y}{5}$

59. $b = \frac{2A - hc}{h}$ or $b = \frac{2A}{h} - c$

61. $x = \frac{8R + 36}{3}$ or $x = \frac{8R}{3} + 12$

63. $y = -x - 12$

65. $C = nt + 9$

67. $C = 325n + 5400$

69. **a.** $I = Prt$

b. $P = \$8000$; $I = \$600$; $t = 0.5$

c. r **d.** $r = 15\%$

71. **a.** $A = \frac{1}{2}bh$ **b.** $b = 3h$

c. $A = \frac{1}{2}(3h)h = \frac{3}{2}h^2$

d. $h^2 = \frac{2}{3}A$

e. Take the square root of both sides

f. 10 **g.** 30 feet

Writing & Thinking

73. **a.** 1 **b.** −1 **c.** 15 **d.** −12

7.6 Exercises

Concept Check

1. consecutive
3. $n+2, n+4$
5. 2
7. True
9. False; Integers that are not even

Practice

1. x = savings account balance in dollars (or other unit of money); $\frac{3}{5}x$
3. s = the length of a side of the square; $4s = 20$
5. $x - 5 = 13 - x$; 9
7. $36 = 2x + 4$; 16
9. $7x = 2x + 35$; 7
11. $3x + 14 = 6 - x$; -2
13. $\frac{2x}{5} = x + 6$; -10
15. $4(x-5) = x + 4$; 8
17. $\frac{2x+5}{11} = 4 - x$; 3
19. $2x + 3x = 4(x+3)$; 12
21. $n + (n+2) = 60$; 29, 31
23. $n + (n+1) + (n+2) = 69$; 22, 23, 24
25. $n + (n+1) + (n+2) + (n+3) = 74$; 17, 18, 19, 20
27. $171 - n = (n+1) + (n+2)$; 56, 57, 58
29. $208 - 3n = (n+1) + (n+2) + (n+3) - 50$; 42, 43, 44, 45
31. $n + 2(n+2) = 4(n+4) - 54$; 42, 44, 46
33. $(n+2) + (n+4) - n = 66$; 60, 62, 64
35. $2n + 3(n+2) = 2(n+4) + 7$; 3, 5, 7

Applications

37. **a.** The unknown value is the number of postcards purchased.
b. $p = 9$
c. Brooke purchased 9 postcards.
39. **a.** The number of slices each pizza was cut into
b. $\frac{1}{4}p + \frac{1}{2}p + \frac{3}{8}p = 9$
c. $p = 8$
d. Each pizza was cut into 8 slices.
41. $(c - 58.96) + c = 96.94$; Flash drive: \$18.99; Printer: \$77.95
43. $7x = 91{,}399$; 13,057
45. $x + x + (x+3) + (x+3+5) = 19$; 2 magazines
47. $50 - 2x = 10.50$; \$19.75
49. $800 + 50(x-2) = 1450$; 15 hours
51. $19.99 + 0.65x = 127.24$; 165 miles
53. $n + 4n - 4 + 2n + 7 = 59$; 8 cm, 28 cm, 23 cm
55. $x + 3x - 1 + 2x + 5 = 64$; 10 inches, 29 inches, 25 inches

Note: Answers for 57 through 61 will vary.

57. Twice a number increased by 3 equals 9; $x = 3$
59. Find 3 consecutive even integers such that the sum of the first and the third is 3 times the second; $n = -2, 0, 2$
61. Find a number such that twice the sum of the number and 2, decreased by 6 is equal to the sum of the number and 4 minus the number; $n = 3$

7.7 Exercises

Concept Check

1. rate, time
3. 12%
5. one
7. False; The value of r should be written as a decimal number.
9. True

Applications

1. **a.** Original price
b. x; $0.20x$ **c.** \$119.95
3. **a.** 2 liters **b.** $0.25x$
c. $x + 20$
d. $0.20(x+20) = 2 + 0.25x$
e. 40 liters
5. **a.** x is the number of quarters in Brian's pocket; $0.10(2q) + 0.25q = 2.70$ $q = 6$, so Brian has 6 quarters and 12 dimes.
b. Check against the language of the problem: 12 is twice as much as 6, and 6 quarters (\$1.50) and 12 dimes (\$1.20) add up to \$2.70.
7. 1.68 mph
9. 8.75 hours
11. 3 hours
13. 50 mph; 300 miles
15. 7 hours
17. 36 mph; 60 mph
19. Day: 56 mph; Night: 69 mph
21. 4.5 miles
23. **a.**

	Rate (mph)	·	Time (min)	=	Distance (miles)
Tortoise	10		t		$10t$
Achilles	25		$t-2$		$25(t-2)$

b. $10t = 25(t-2)$
c. $3\frac{1}{3}$ hours
d. $1\frac{1}{3}$ hours **e.** Yes
25. \$7400 at 5.5%; \$2600 at 6%
27. \$7000 at 6%; \$9000 at 8%
29. \$5500 at 8%; \$6500 at 10%
31. **a.**

	Principal (\$)	·	Rate	=	Interest (\$)
High-Risk Fund	P		0.08		$0.08P$
Low-Risk Fund	$3600 - P$		0.04		$0.04(3600 - P)$

b. $0.08P + 0.04(3600 - P) = 198$
c. $P = \$1350$
d. High-risk fund: \$1350; Low-risk fund: \$2250
e. Answer will vary.
33. \$6720 at 5.5%; \$5280 at 7%
35. \$600 at 2.5%; \$800 at 4%
37. \$11,000 at 4%; \$9500 at 5%
39. \$40.50
41. \$113.75
43. **a.** \$1140
b. $x - 0.05x$ or $0.95x$
c. $x - 0.05x - 2850 = 1140$ or $0.95x - 2850 = 1140$
d. \$4200
e. Robin's Refurbished Wrecks should sell the used car for \$4200.
45. 94
47. 4 phone calls
49. \$20
51. **a.** Not possible
b. 192
53. **a.** 3.2 inches
b. 7.1 inches
c. 6.9 inches
55. **a.** 80.4 million
b. 26 million
c. 75 million

Writing & Thinking

57. If each equal side is 9 cm long, that would make the perimeter more than 18 cm; Correct answer: 6 cm

59. He would not be able to paddle faster than the current, so he would not be able to return upriver at all;

Correct answer: $\frac{2}{3}$ mph

7.8 Exercises

Concept Check

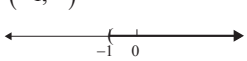
1. interval **3.** closed

5. addition **7.** True

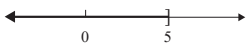
9. False; Only one value in the solution set needs to be checked.

Practice

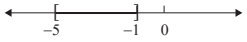
1. $(-1,\infty)$



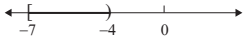
3. $(-\infty,5]$



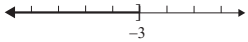
5. $[-5,-1]$



7. $[-7,-4)$

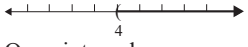


9.



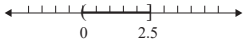
Half-open interval

11.



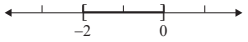
Open interval

13.



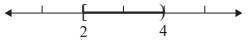
Half-open interval

15.



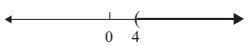
Closed interval

17.

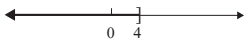


Half-open interval

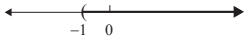
19. $(4,\infty)$



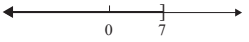
21. $(-\infty,4]$



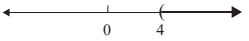
23. $(-1,\infty)$



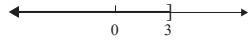
25. $(-\infty,7]$



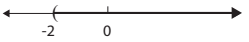
27. $(4,\infty)$



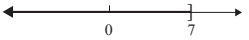
29. $(-\infty,3]$



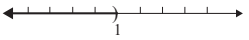
31. $(-2,\infty)$



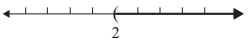
33. $(-\infty,7]$



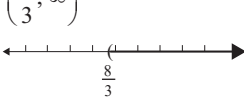
35. $(-\infty,1)$



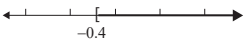
37. $(2,\infty)$



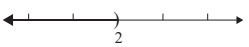
39. $\left(\frac{8}{3},\infty\right)$



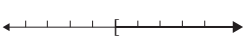
41. $[-0.4,\infty)$



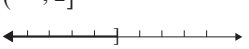
43. $(-\infty,2)$



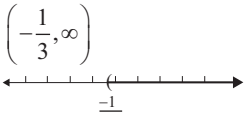
45. $[3,\infty)$



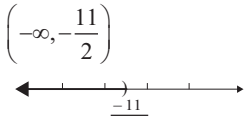
47. $(-\infty,2]$



49. $\left(-\frac{1}{3},\infty\right)$

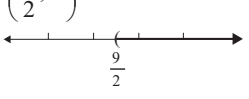


51. $\left(-\infty,-\frac{11}{2}\right)$

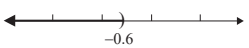


53. $[1,\infty)$

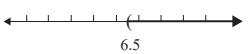
55. $\left(\frac{9}{2},\infty\right)$



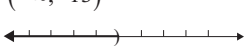
57. $(-\infty,-0.6)$



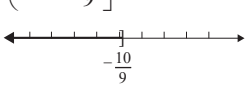
59. $(6.5,\infty)$



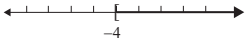
61. $(-\infty,-13)$



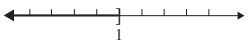
63. $\left(-\infty,-\frac{10}{9}\right]$



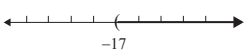
65. $[-4,\infty)$



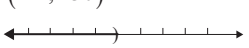
67. $(-\infty,1]$



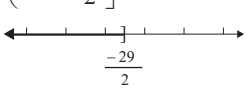
69. $(-17,\infty)$



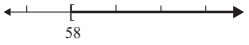
71. $(-\infty,-30)$



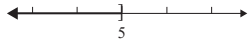
73. $\left(-\infty,-\frac{29}{2}\right]$



75. $x \geq 58$



77. $x \leq 5$



Applications

79. a. The student would need a score higher than 102 points, which is not possible. Thus he cannot earn an A in the course.

b. The student must score at least 192 points to earn an A in the course.

81. He must sell at least 10 cars.

83. a. $15 - x$

b. $8x + 5(15 - x)$

c. 8 large arrangements

85. $100 - 5(x - 3) \geq 70$; 9 unexcused absences

87. 22,500 tickets

89. 8 times

91. a. $150 + 60 + 12.50c \leq 400$

b. If you solve the inequality you get $c \leq 15.2$, but you can't buy 0.2 ink cartridges, so $c \leq 15$.

c. Jeph can buy at most 15 ink cartridges.

93. a. $\frac{92 + 74 + 80 + 72 + E}{5} \geq 80$

b. $E \geq 82$

c. Andrew needs to earn at least an 82 on the fifth exam.

7.9 Exercises

Concept Check

1. elements

3. such that

5. roster

7. False; The union of two sets contains elements that belong to either one set, the other set, or both sets.

9. True

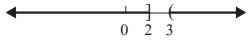
Practice

1. Union: $\{1, 2, 3, 4, 6, 8\}$; Intersection: $\{2, 4\}$

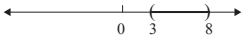
3. Union: $\{-4, -3, -2, -1, 0, 1, 2, 4, 6\}$; Intersection: $\{0\}$

5. Union: $\{1, 2, 4, 8, 16, 32, 64\}$; Intersection: $\{1, 4, 16\}$

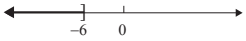
7. $(3,\infty) \cup (-\infty,2]$



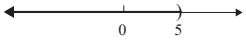
9. $(3, 8)$



11. $(-\infty, -6]$

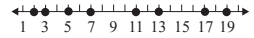


13. $(-\infty, 5)$



15.

17.



19. $\{x \mid 3 \le x < 5\}$

21. $\{x \mid x \ge -2.5\}$

23. a. $\{x \mid -3 \le x \le 1\}$

b. $[-3, 1]$

25. a. $\{x \mid -8 < x \le -2\}$

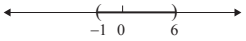
b. $(-8, -2]$

27. a. $\{x \mid x \le 1\}$ **b.** $(-\infty, 1]$

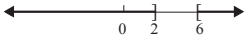
29. a. $\{x \mid -4 < x < 4\}$

b. $(-4, 4)$

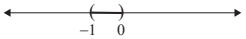
31. $(-1, 6)$



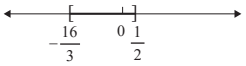
33. $(-\infty, 2] \cup [6, \infty)$



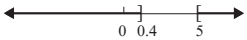
35. $(-1, 0)$



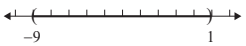
37. $\left[-\frac{16}{3}, \frac{1}{2}\right]$



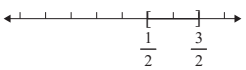
39. $(-\infty, 0.4] \cup [5, \infty)$



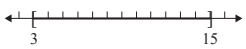
41. $(-9, 1)$



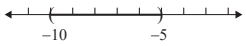
43. $\left[\frac{1}{2}, \frac{3}{2}\right]$



45. $[3, 15]$



47. $(-10, -5)$



49. $(-2.8, -0.3)$

Writing & Thinking

51. Answers will vary. Answers should mention that *and* indicates the intersection and *or* indicates the union.

7.10 Exercises

Concept Check

1. standard

3. distance

5. False; Equations involving absolute value can have more than one solution.

7. True

Practice

1. $x = -8, 8$

3. No solution

5. $x = -5, -1$

7. $x = -\frac{4}{3}, \frac{5}{3}$

9. $n = -2, \frac{2}{3}$

11. No solution

13. $x = 2$

15. $x = -\frac{3}{2}, 2$

17. $x = -\frac{1}{5}, 1$

19. $x = -\frac{1}{3}, 3$

21. $x = -22, 26$

23. $x = -8, 4$

25. $x = -6, 0$

27. $x = -\frac{1}{3}, 3$

29. $x = 1$

31. $x = -\frac{5}{2}, \frac{3}{4}$

33. $x = -\frac{20}{7}, \frac{4}{5}$

35. $x = -20, \frac{40}{9}$

7.11 Exercises

Concept Check

1. standard

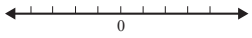
3. or

5. False; Only one statement/inequality must be true.

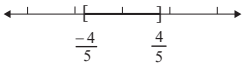
7. False; Must be greater than 2

Practice

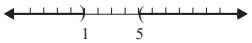
1. $(-\infty, \infty)$



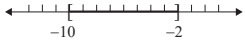
3. $\left[-\frac{4}{5}, \frac{4}{5}\right]$



5. $(-\infty, 1) \cup (5, \infty)$

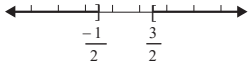


7. $[-10, -2]$

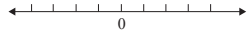


9. $(-\infty, -8] \cup [-2, \infty)$

11. $\left(-\infty, -\frac{1}{2}\right] \cup \left[\frac{3}{2}, \infty\right)$

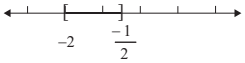


13.

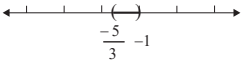


No solution

15. $\left[-2, -\frac{1}{2}\right]$



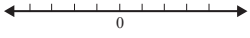
17. $\left(-\frac{5}{3}, -1\right)$



19. $\left(-\infty, -\frac{2}{3}\right] \cup [6, \infty)$

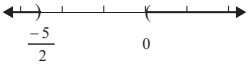
21. $[-1, 10]$

23. $(-\infty, \infty)$

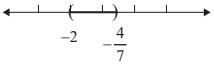


25. $\left(\frac{1}{2}, \frac{7}{2}\right)$

27. $\left(-\infty, -\frac{5}{2}\right) \cup (0, \infty)$



29. $\left(-2, -\frac{4}{7}\right)$



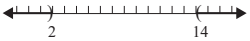
Writing & Thinking

31. a.

b. $|x| \le 10$

c. $[-10, 10]$, Closed interval

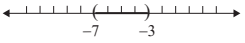
33. a.



b. $|x - 8| > 6$

c. $(-\infty, 2) \cup (14, \infty)$

35. a.



b. $|x + 5| < 2$

c. $(-7, -3)$, Open interval

Chapter 8: Graphing Linear Equations and Inequalities

8.1 Exercises

Concept Check

1. quadrants **3.** III

5. origin **7.** True

9. True

Practice

1. $\{A(-5,1), B(-3,3), C(-1,1), D(1,2), E(2,-2)\}$

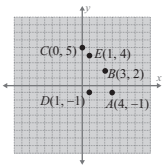
3. $\{A(-3,-2), B(-1,-3), C(-1,3), D(0,0), E(2,1)\}$

5. $\{A(-4,4), B(-3,-4), C(0,-4), D(0,3), E(4,1)\}$

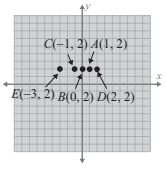
7. $\{A(-3,-5), B(-1,4), C(0,-1), D(3,1), E(6,0)\}$

9. $\{A(-5,0), B(-2,2), C(-1,-4), D(0,6), E(2,0)\}$

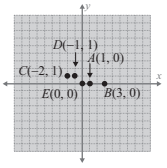
11.



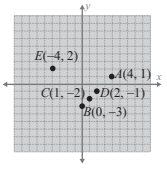
13.



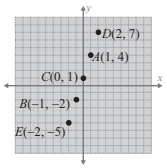
15.



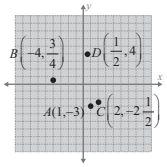
17.



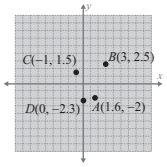
19.



21.



23.



25. $(0,-4), (2,-2), (4,0), (1,-3)$

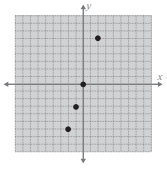
27. $(0,3), (2,2), (6,0), (-2,4)$

29. $(0,-8), (1,-4), (2,0), (3,4)$

31. $(0,2), \left(-1,\frac{8}{3}\right), (3,0), (6,-2)$

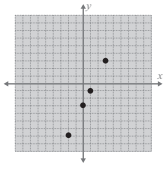
33. $\left(0,-\frac{7}{4}\right), (1,-1), \left(\frac{7}{3},0\right) \left(3,\frac{1}{2}\right)$

35.



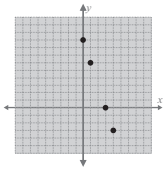
$(0,0), (-1,-3), (-2,-6), (2,6)$

37.



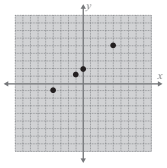
$(0,-3), (1,-1), (-2,-7), (3,3)$

39.



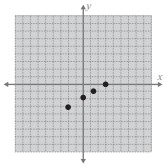
$(0,9), (3,0), (1,6), (4,-3)$

41.



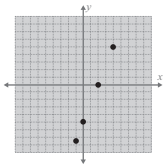
$(0,2), (4,5), (-4,-1), \left(-1,\frac{5}{4}\right)$

43.



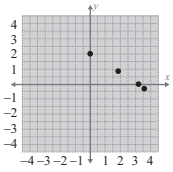
$\left(0,-\frac{9}{5}\right), (3,0), (-2,-3), \left(\frac{4}{3},-1\right)$

45.



$(0,-5), (2,0), \left(-1,-\frac{15}{2}\right), (4,5)$

47.



$(0,2), (3.2,0), (1.92,0.8), (3.52,-0.2)$

49. b, c, d

51. a, d

53. a, c, d

55. For example, $(-3,-3)$, $(0,1)$, and $(3,5)$.

57. For example, $(-3,-1)$, $(0,0)$, and $(3,1)$.

59. For example, $(-2,3)$, $(0,3)$, and $(4,3)$.

61. For example, $(-4,-4)$, $(0,-3)$, and $(4,-2)$.

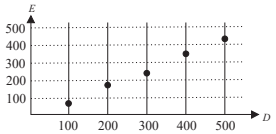
63. For example, $(-3,-3)$, $(-2,0)$, and $(-1,3)$.

Applications

65. a.

D	E
100	85
200	170
300	255
400	340
500	425

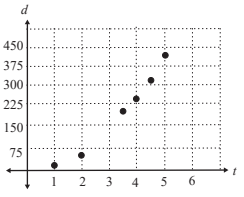
b.



67. a.

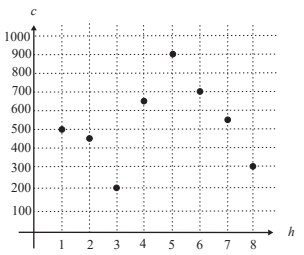
t	d
1	16
2	64
3.5	196
4	256
4.5	324
5	400

b.



c. The time t is squared in the equation.

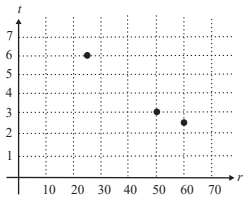
69.



71. a.

r (mph)	t (hours)
25	6
50	3
60	2.5

b.



c. The time decreases as the rate increases.

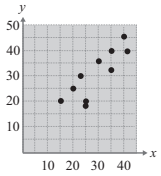
d.

r (mph)	t (hours)
30	5
60	2.5
150	1
300	0.5
1500	0.1

e. Answers will vary. Rate increases as the time decreases.

Writing & Thinking

73. a.



b. Yes, the more push-ups a person can do it appears the more sit-ups he/she can do.

c. 24 sit-ups, 33 sit-ups, 36 sit-ups, 45 sit-ups. Answers will vary.

75. Answers will vary. Not all scatter plots can be used to predict information related to the two variables graphed because not all variables are related.

8.2 Exercises

Concept Check

1. y **3.** infinite

5. line **7.** True

9. False; Horizontal lines have y-intercepts.

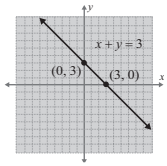
Practice

1. **a.**

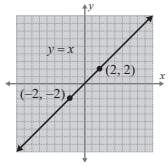
3. **d.**

5. **f.**

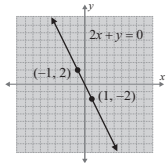
7.



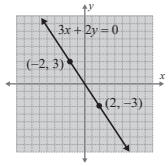
9.



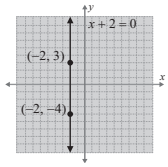
11.



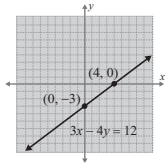
13.



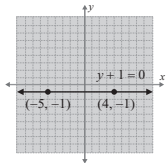
15.



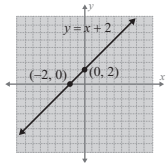
17.



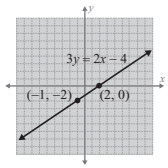
19.



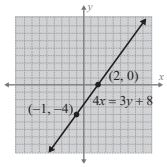
21.



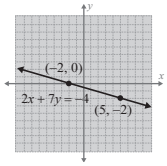
23.



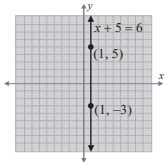
25.



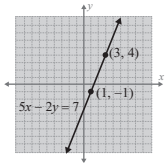
27.



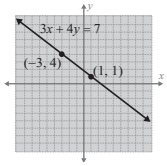
29.



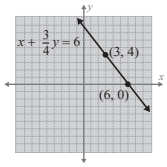
31.



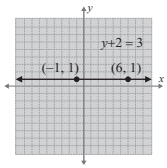
33.



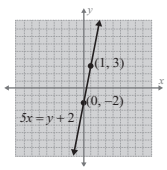
35.



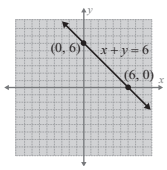
37.



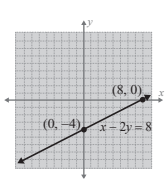
39.



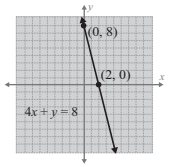
41.



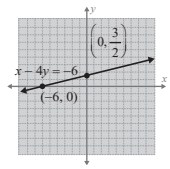
43.



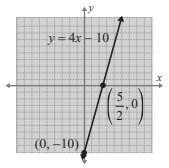
45.



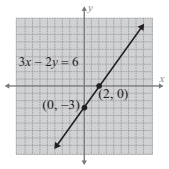
47.



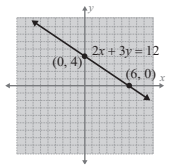
49.



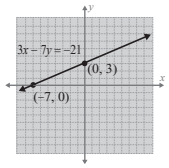
51.



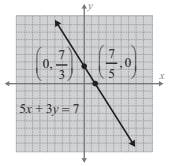
53.



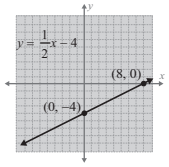
55.



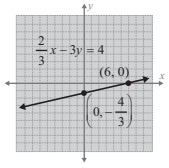
57.



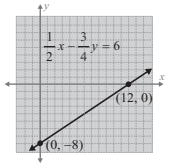
59.



61.



63.

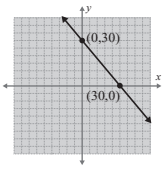


Applications

65. The x-intercept is $(12, 0)$ meaning that after 12 days, there will be 0 mg of potassium remaining in the bottle of sports drink. The y-intercept is $(0, 360)$ meaning that the original amount of potassium in the sports drink is 360 mg.

67. **a.** C-intercept: $(30, 0)$
P-intercept: $(0, 30)$

b.



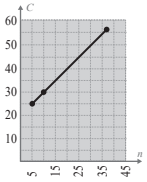
c. Answers will vary. Negative number of cookies; Total amount of cookies is over 30 dozen.

d. 14 dozen chocolate chip cookies

69. **a.**

n	5	10	37
C	25	30	57

b.



c. Answers will vary. Negative number of songs; Negative cost.

d. \$57

Writing & Thinking

71. Substitute the x and y values into the equation. Then evaluate both sides to see if the equation is true.

8.3 Exercises

Concept Check

1. run **3.** positive

5. 0 **7.** True

9. True

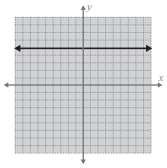
Practice

1. $m = 5$ 3. $m = -\frac{1}{7}$

5. $m = 0$ **7.** $m = \frac{1}{2}$

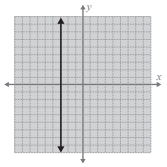
9. $m = 2$ **11.** $m = \frac{1}{5}$

13.



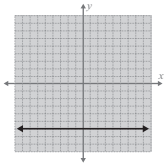
Horizontal line; $m = 0$

15.



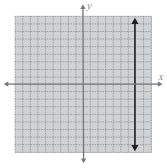
Vertical line; m is undefined

17.



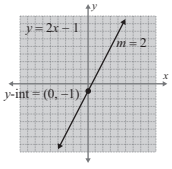
Horizontal line; $m = 0$

19.

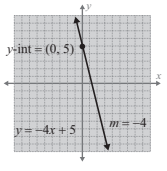


Vertical line; m is undefined

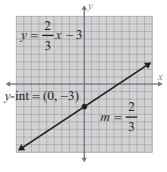
21.



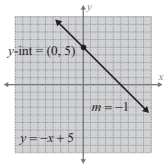
23.



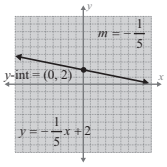
25.



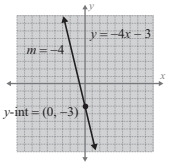
27.



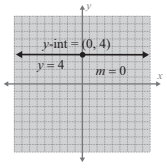
29.



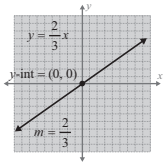
31.



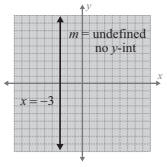
33.



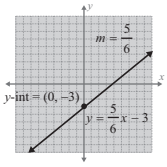
35.



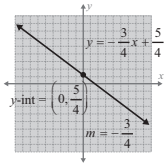
37.



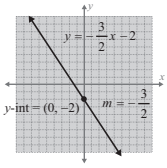
39.



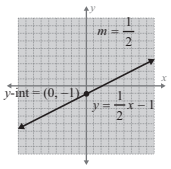
41.



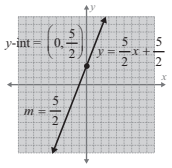
43.



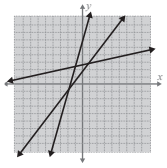
45.



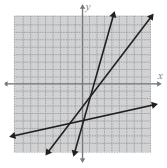
47.



49. Answers will vary.



51. Answers will vary.



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

55. $y = \frac{2}{5}x - 3$

57. $y = 4x - 5$

59. $y = x - 4$

61. $y = -\frac{5}{6}x - 3$

63. **a.** $m = -\frac{1}{6}$ **b.** $\left(0, \frac{5}{2}\right)$

c. $y = -\frac{1}{6}x + \frac{5}{2}$

65. **a.** $m = 0$ **b.** $(0, -6)$

c. $y = -6$

67. **a.** $m = \frac{1}{2}$ **b.** $(0, -3)$

c. $y = \frac{1}{2}x - 3$

69. **a.** $m = -\frac{1}{3}$ **b.** $(0, 2)$

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

71. Yes

73. No

75. Yes

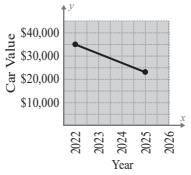
Applications

77. $\frac{3}{4}$

79. $\frac{11}{10}$

81. 54 mph

83. $4000/year



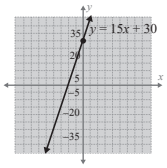
85. –5.66

87. **a.** Slope is $15; Units are dollars and paintings

b. $(0, 30)$

c. $y = 15x + 30$

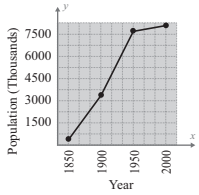
d.



e. Answers will vary. x cannot be negative since you can't sell a negative number of paintings.

f. $90

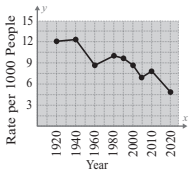
89. **a.** and **b.**



c. 58,433.1; 89,095.1; 2326.42

d. The population of New York increased by 58,433 people/year from 1850-1900; 89,095 ppy from 1900-1950; and 2326 ppy from 1950-2000.

91. **a.** and **b.**



c. –0.18, 0.075, –0.02, –0.13, –0.14, –0.17

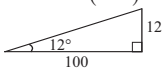
d. # of marriages decreased 0.18 marriages/1000 people people from '40–'60, increased 0.075 marriages/1000 people from '60–'80, decreased 0.02 marriages/1000 people from '80–'90, decreased 0.13 marriages/1000 people from '90–'00, decreased 0.14 marriages/1000 people from '00–'10, and decreased 0.17 marriages/1000 people per year from '10–'20.

Writing & Thinking

93. **a.** The x-axis

b. The y-axis

95. A grade of 12% means that the slope of the road is 0.12. For every 100 feet of horizontal distance (run) there is a vertical distance (rise) of 12 feet.



8.4 Exercises

Concept Check

1. negative reciprocals

3. same

5. slope

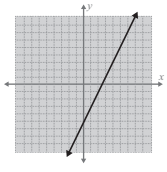
7. True

9. True

Practice

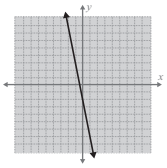
1. **a.** $m = 2$ **b.** $(3,1)$

c.



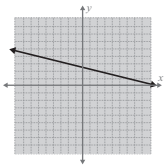
3. **a.** $m = -5$ **b.** $(0,-2)$

c.

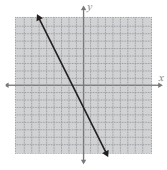


5. **a.** $m = -\frac{1}{4}$ **b.** $(-2,3)$

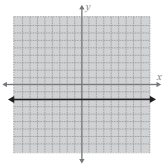
c.



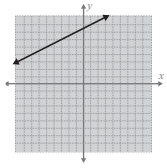
7. $2x + y = -3$



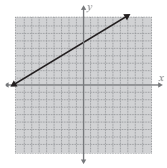
9. $y = -2$



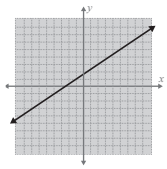
11. $x - 2y = -15$



13. $3x - 5y = -29$



15. $2x - 3y = -5$



17. $y = \frac{1}{2}x + \frac{9}{2}$

19. $y = -\frac{1}{7}x + \frac{2}{7}$

21. $y = -\frac{5}{4}x + 2$

23. $y = -5$

25. $y = -x + 4$

27. $x - y = 1$

29. $3x + y = 2$

31. $3x - 4y = -14$

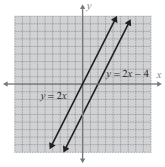
33. $7x + 3y = -5$

35. $y = 6$

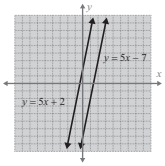
37. $y = 7$

39. $y = 7$

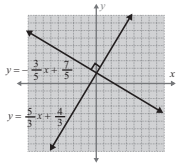
41. $y = 2x$



43. $y = 5x + 2$



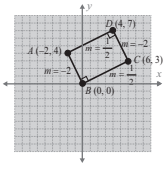
45. $y = -\frac{3}{5}x + \frac{7}{5}$



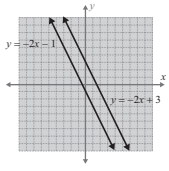
47. $y = -\frac{1}{3}x$

49. $y = -\frac{1}{2}x - 2$

51.

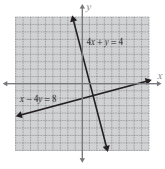


53.



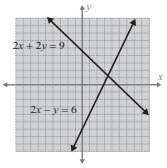
Parallel

55.



Perpendicular

57.



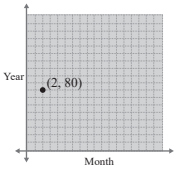
Neither

Applications

59. **a.** $P = 100t - 5000$

b. 50 tickets

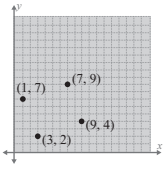
61. **a.**



b. $y - 80 = 10(x - 2)$

63. **a.** $f = 5 + 2m$ **b.** \$35

65. **a.**



b. Top: $m = \frac{1}{3}$;

Bottom: $m = \frac{1}{3}$;

Left: $m = -\frac{5}{2}$

Right: $m = -\frac{5}{2}$

c. Top is parallel with bottom, left is parallel with right.

d. No

e. Parallelogram

8.5 Exercises

Concept Check

1. function

3. domain

5. domain

7. True

9. True

Practice

1. $\{(-4, 0), (-1, 4), (1, 2), (2, 5), (6, -3)\}$;

$D = \{-4, -1, 1, 2, 6\}$;

$R = \{-3, 0, 2, 4, 5\}$;

Function

3. $\{(-5, -4), (-4, -2), (-2, -2), (1, -2), (2, 1)\}$;

$D = \{-5, -4, -2, 1, 2\}$;

$R = \{-4, -2, 1\}$;

Function

5. $\{(-4, -3), (-4, 1), (-1, -1), (-1, 3), (3, -4)\}$;

$D = \{-4, -1, 3\}$;

$R = \{-4, -3, -1, 1, 3\}$;

Not a function

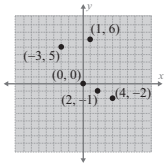
7. $\{(-5, -5), (-5, 3), (0, 5), (1, -2), (1, 2)\}$;

$D = \{-5, 0, 1\}$;

$R = \{-5, -2, 2, 3, 5\}$;

Not a function

9.

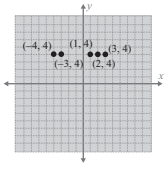


$D = \{-3, 0, 1, 2, 4\}$;

$R = \{-2, -1, 0, 5, 6\}$;

Function

11.

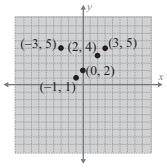


$D = \{-4, -3, 1, 2, 3\}$;

$R = \{4\}$;

Function

13.

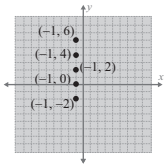


$D = \{-3, -1, 0, 2, 3\}$;

$R = \{1, 2, 4, 5\}$;

Function

15.



$D = \{-1\}$;

$R = \{-2, 0, 2, 4, 6\}$;

Not a function

17. Function;

$D = (-\infty, \infty)$;

$R = [0, \infty)$

19. Function;

$D = (-\infty, \infty)$;

$R = (-\infty, \infty)$

21. Not a function;

$D = (-\infty, \infty)$;

$R = (-\infty, \infty)$

23. Not a function;

$D = (-\infty, \infty)$;

$R = (-\infty, \infty)$

25. Function;

$D = [-5, 5]$;

$R = [-2, 2]$

27. Not a function;

$D = \{-3\}$;

$R = (-\infty, \infty)$

29. $\left\{(-9, -26), \left(-\frac{1}{3}, 0\right), (0, 1), \left(\frac{4}{3}, 5\right), (2, 7)\right\}$

31. $\{(-2, -11), (-1, -2), (0, 1), (1, -2), (2, -11)\}$

33. $D = (-\infty, \infty)$

35. $D = (-\infty, 0) \cup (0, \infty)$ or $x \neq 0$

37. $D = (-\infty, 3) \cup (3, \infty)$ or $x \neq 3$

39. **a.** −4 **b.** −16 **c.** −10

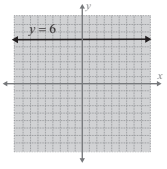
41. **a.** 0 **b.** 12 **c.** 56

43. **a.** −3 **b.** 0 **c.** 3

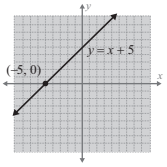
45. $f(1) = 3$

47. $f(4) = 0$

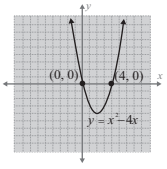
49.



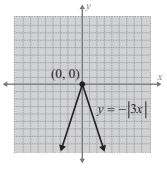
51.



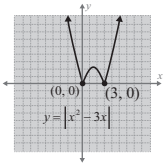
53.



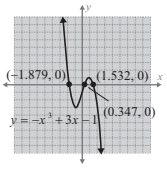
55.



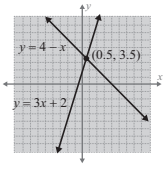
57.



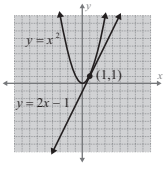
59.



61.



63.



65. y-intercept = $(0,-5)$ (should be $(0,5)$)

67. y-intercept = $(0,-8)$ (should be $(0,-2)$)

69. Slope = -3 (should be the reciprocal, $-\frac{1}{3}$) and y-intercept = $(0,2)$ (should be $(0,0)$)

Applications

71. **a.** $(0, 250)$, represents Ariella's base weekly salary

b. 0.15; Represents the commission rate

c. $y = 0.15x + 250$

d. $f(x) = 0.15x + 250$

e. Domain is all real numbers; Range is all real numbers

f. Answers will vary. Some students may say sales cannot be negative, some will allow negative sales due to returns.

g. \$1000

8.6 Exercises

Concept Check

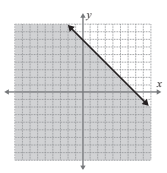
1. test **3.** open

5. closed **7.** True

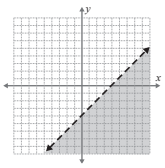
9. False; The boundary line is solid if the inequality uses ≤ or ≥.

Practice

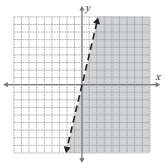
1.



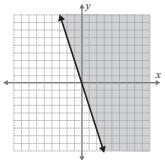
3.



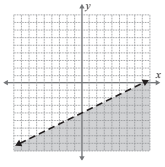
5.



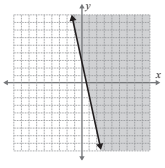
7.



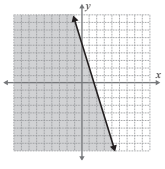
9.



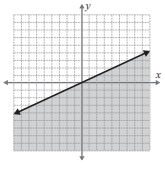
11.



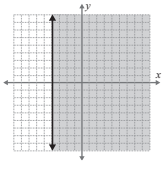
13.



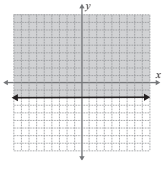
15.



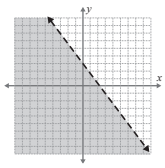
17.



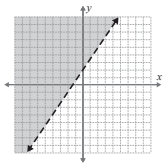
19.



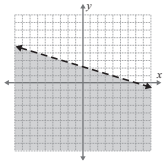
21.



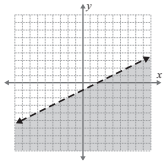
23.



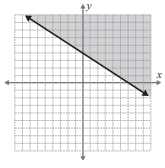
25.



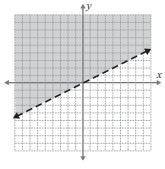
27.



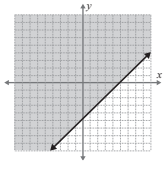
29.



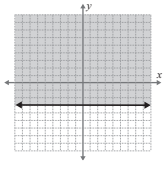
31.



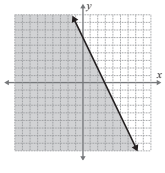
33.



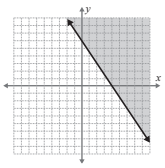
35.



37.



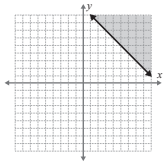
39.



Applications

41. **a.** $x + y \geq 75$

b.



c. No; $67 < 75$

d. Answers will vary; Any points with x or $y < 0$ or > 50.

43. **a.**

Domain, d	Range, m
1	$\frac{23}{10}$
2	$\frac{13}{5}$
3	$\frac{29}{10}$
4	$\frac{16}{5}$
5	$\frac{7}{2}$
6	$\frac{19}{5}$
7	$\frac{41}{10}$

b. 6.2

Writing & Thinking

45. A closed half-plane includes points on the line and is symbolized by a solid boundary line. An open half-plane does not include points on the line and is symbolized by a dashed boundary line.

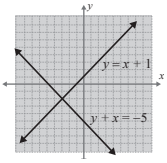
Chapter 9: Systems of Linear Equations

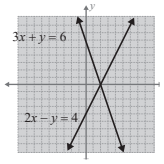
9.1 Exercises

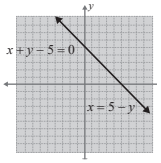
Concept Check

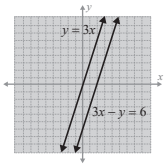
1. simultaneous
3. same
5. one
7. False; The solution must be checked in all equations.
9. True

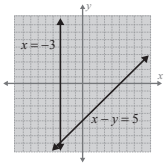
Practice

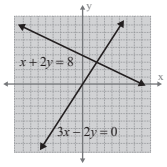
1. c
3. a, c
5. $(0, 2)$
7. $(4, 2)$
9. $m_1 = -2, b_1 = 3,$ $m_2 = -2, b_2 = \frac{5}{2}$
11. $m_1 = \frac{1}{2}, b_1 = 3,$ $m_2 = \frac{1}{2}, b_2 = -\frac{1}{2}$
13. 

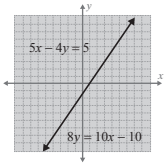
$(-3, -2)$; Consistent; Independent
15. 

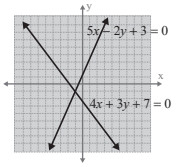
$(2, 0)$; Consistent; Independent
17. 

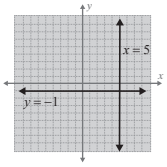
$(x, -x + 5)$; Consistent; Dependent
19. 

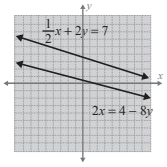
No solution; Inconsistent; Independent
21. $(-3, -8)$ 

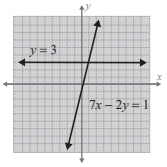
23. $(2, 3)$ 

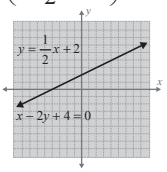
25. $\left(x, \frac{5}{4}x - \frac{5}{4}\right)$ 

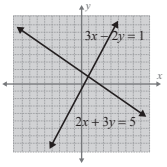
27. $(-1, -1)$ 

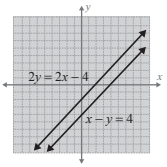
29. $(5, -1)$ 

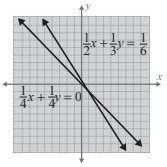
31. No solution 

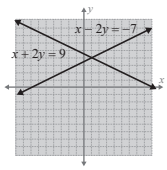
33. $(1, 3)$ 

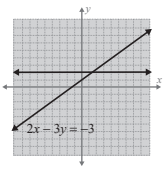
35. $\left(x, \frac{1}{2}x + 2\right)$ 

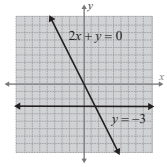
37. $(1, 1)$ 

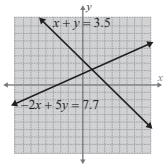
39. No solution 

41. $(1, -1)$ 

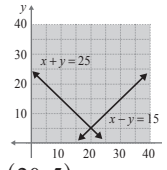
43. $(1, 4)$ 

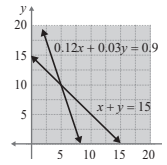
45. $(1.5, 2)$ 

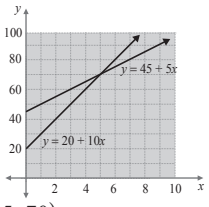
47. $(1.5, -3)$ 

49. $(1.4, 2.1)$ 

Applications

51. 

$(20, 5)$
53. 

5 gallons of 12%; 10 gallons of 3%
55. 134 hours
57. **a.** Fit4life: $y = 20 + 10x$; Workout Nation: $y = 45 + 5x$
b. 

c. $(5, 70)$
d. The gym memberships will cost the same amount per month if 5 classes are taken.
e. Workout Nation

Writing & Thinking

59. The solution to a consistent system of linear equations is a single point, which is easily written as an ordered pair.

9.2 Exercises

Concept Check

1. variables
3. no
5. back substitution
7. True
9. True

Practice

1. $(2, 4)$
3. $(x, 3x-7)$
5. $(-6, -2)$
7. $(4, 1)$
9. No solution
11. $(3, 2)$
13. $(4, -5)$
15. $(3, -2)$
17. $\left(2, \frac{5}{2}\right)$
19. $\left(\frac{1}{2}, -4\right)$
21. $\left(\frac{7}{2}, -\frac{1}{2}\right)$
23. $(x, 2-3x)$
25. $(-2, 1)$
27. $\left(-\frac{4}{5}, -\frac{7}{5}\right)$
29. $\left(\frac{11}{7}, \frac{8}{7}\right)$
31. $\left(x, \frac{1}{6}x+\frac{10}{3}\right)$
33. $(3, 3)$
35. $(10, 20)$
37. No solution
39. $\left(x, -\frac{3}{2}x+12\right)$
41. $\left(2, \frac{5}{3}\right)$

Applications

43. $(20, 5)$
45. 5 gallons of 12%; 10 gallons of 3%
47. 3 months
49. **a.** $\begin{cases} c = 45 + 0.15t \\ c = 55 + 0.10t \end{cases}$

    b. $t = 200$, $c = 75$

    c. The plans will both cost \$75 when 200 text messages are sent.

    d. More than 200 text messages

Writing & Thinking

51. Answers will vary.

9.3 Exercises

Concept Check

1. eliminate
3. standard
5. combining
7. False; The solution always needs to be checked in both original equations.
9. False; Both methods give exact solutions.

Practice

1. $(4, 3)$
3. $\left(1, -\frac{3}{2}\right)$
5. No solution
7. $(x, 3-x)$
9. $(-2, -3)$
11. $(7, 5)$
13. $(1, -5)$
15. $\left(x, \frac{1}{2}x-2\right)$
17. $\left(\frac{22}{7}, -\frac{2}{7}\right)$
19. $(2, -2)$
21. $(x, 2x-4)$
23. $(2, -1)$
25. $(5, -6)$
27. $(3, -1)$
29. $(2, 4)$
31. $(-6, 2)$
33. No solution
35. $(20, 10)$
37. $\left(2, \frac{10}{9}\right)$
39. No solution
41. $\left(-\frac{45}{7}, \frac{92}{7}\right)$
43. $y = 5x - 7$; $m = 5$, $b = -7$
45. $y = -3$; $m = 0$, $b = -3$
47. $y = \frac{1}{2}x + \frac{3}{2}$; $m = \frac{1}{2}$, $b = \frac{3}{2}$

Applications

49. $y = 25x + 50$
51. \$4000 at 10%; \$6000 at 6%
53. 40 liters of 30% solution (x), 60 liters of 40% solution (y)
55. **a.** $\begin{cases} y = 3500 + 1.5x \\ y = 1000 + 2x \end{cases}$

    b. $x = 5000$, $y = 11{,}000$

    c. The cards will earn the same amount of rewards points if you spend \$5000.

    d. City

Writing & Thinking

57. Answers will vary.

9.4 Exercises

Practice

1. 23, 33
3. 15, 21
5. 37, 50

Applications

7. 80°, 100°
9. 55°, 55°, 70°
11. The rate of the boat is 10 mph and the rate of the current is 2 mph.
13. Bolt's speed was 10.32 meters per second and the wind speed was 0.12 meters per second.
15. He traveled $1\frac{1}{2}$ hours at 52 mph and 2 hours at 56 mph.
17. Marcos traveled at 40 mph and Cana traveled at 51 mph.
19. Steve traveled at 28 mph and Tim traveled at 7 mph.
21. The westbound train was traveling 45 mph and the eastbound train was traveling 40 mph.
23. He jogged 12 miles.
25. 20 nickels and 10 dimes
27. 52 nickels and 130 pennies
29. 800 adults and 2700 children attended.
31. $l = 14$ meters; $w = 8$ meters
33. 100 yards × 45 yards
35. $l = 33$ meters; $w = 17$ meters
37. Priscilla was 21 years old and Elvis was 32 years old.
39. She bought 10 paperbacks and 5 hardbacks.
41. 5000 general admission and 7500 reserved tickets were sold.
43. 22 at \$625 and 25 at \$550
45. 30 dozen (360 balls)
47. The store sold 22 of the \$95 jackets and 18 of the \$120 jackets.
49. One Big Mac costs \$4.11 and one order of medium French fries costs \$1.84.
51. They will produce 7 of Model X and 10 of Model Y.
53. **a.** $\begin{cases} 5c + 10a = 1400 \\ c + a = 200 \end{cases}$

    b. $c = 120$, $a = 80$

    c. 120 children and 80 adults visited the petting zoo on Tuesday.

Writing & Thinking

55. The number is 49.

9.5 Exercises

Concept Check

1. payment, interest

3. paid or earned

5. time

7. False; When interest is calculated on an annual basis, $t = 1$.

9. True

Applications

1. \$5500 at 6%; \$3500 at 10%

3. \$7400 at 5.5%; \$2600 at 6%

5. \$450

7. \$3500 in each or \$7000 total

9. \$20,000 at 24%; \$11,000 at 18%

11. \$800 at 5%; \$2100 at 7%

13. \$8500 at 9%; \$3500 at 11%

15. \$87,000 in bonds; \$37,000 in certificates

17. 20 pounds of 20%; 30 pounds of 70%

19. 20 ounces of 30%; 30 ounces of 20%

21. 450 pounds of 35%; 1350 pounds of 15%

23. 20 pounds of 40%; 30 pounds of 15%

25. 10 g of pure acid; 20 g of the 40% solution

27. 10 oz of salt; 50 oz of the 4% solution

29. 2 lb of 72%; 4 lb of 42%

31. 7.11 ounces of 0.5% solution; 0.89 ounces of the 5% solution

33. a. $\begin{cases} x + y = 5000 \\ 0.04x + 0.09y = 350 \end{cases}$

Account	Principal	·	Interest Rate	=	Interest
Account A	x		0.04		$0.04x$
Account B	y		0.09		$0.09y$
Totals	\$5000		N/A		\$350

b. $x = 2000, y = 3000$

c. Sanjay should invest \$2000 in Account A and \$3000 in Account B to earn \$350 in interest.

d. Yes; Invest more in Account B.

35. a. $5x + 7.50y = 6.50$; $x + y = 1$

b. $x = 0.4, y = 0.6$

c. The manager should mix 0.4 pounds of cashews with 0.6 pounds of almonds to create a mixture which will cost \$6.50 for a one-pound bag.

9.6 Exercises

Concept Check

1. $Ax + By + Cz = D$

3. infinite

5. octants

7. False; Choose 2 equations, eliminate 1 variable.

9. True

Practice

1. $(1, 0, 1)$

3. $(1, 2, -1)$

5. Infinite number of solutions

7. $(4, 1, 1)$

9. $(1, 2, -1)$

11. $(-2, 3, 1)$

13. No solution

15. $(3, -1, 2)$

17. $(2, 1, -3)$

19. $\left(\frac{1}{2}, \frac{1}{3}, -1\right)$

Applications

21. a. $\begin{cases} x + y + z = 16 \\ 10x + 6y + 4z = 92 \\ x + y = z \end{cases}$

b. $(3, 5, 8)$

c. Each bouquet will have 3 lilies, 5 roses, and 8 daisies.

23. 34, 6, 27

25. 18 ones, 16 fives, 12 tens

27. 19 cm, 24 cm, 30 cm

29. Bananas: \$0.60/lb; Apples: \$1.60/lb; Grapes: \$3.60/lb

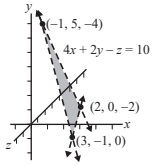
31. Savings: \$30,000; Bonds: \$55,000; Stocks: \$15,000

33. 3 liters of 10%, 4.5 liters of 30%, 1.5 liters of 40%

Writing & Thinking

35. No. Graphically, the three planes intersect at one point (one solution), or in a line (infinitely many solutions) or, they do not have a common intersection (no solution).

37. $A = 4, B = 2, C = -1$



9.7 Exercises

Concept Check

1. matrix, matrices

3. dimension

5. augmented

7. False; A matrix that has 3 rows and 5 columns is a 3 x 5 matrix.

9. False; Interchanging two equations in a system of linear equations will not change the solution.

Practice

1. $\begin{bmatrix} 2 & 2 \\ 5 & -1 \end{bmatrix}, \left[\begin{array}{cc|c} 2 & 2 & 13 \\ 5 & -1 & 10 \end{array}\right]$

3. $\begin{bmatrix} 7 & -2 & 7 \\ -5 & 3 & 0 \\ 0 & 4 & 11 \end{bmatrix}, \left[\begin{array}{ccc|c} 7 & -2 & 7 & 2 \\ -5 & 3 & 0 & 2 \\ 0 & 4 & 11 & 8 \end{array}\right]$

5. $\begin{bmatrix} 3 & 1 & -1 & 2 \\ 1 & -1 & 2 & -1 \\ 0 & 2 & 5 & 1 \\ 1 & 3 & 0 & 3 \end{bmatrix}, \left[\begin{array}{cccc|c} 3 & 1 & -1 & 2 & 6 \\ 1 & -1 & 2 & -1 & -8 \\ 0 & 2 & 5 & 1 & 2 \\ 1 & 3 & 0 & 3 & 14 \end{array}\right]$

7. $\begin{cases} -3x + 5y = 1 \\ -x + 3y = 2 \end{cases}$

9. $\begin{cases} x + 3y + 4z = 1 \\ 2x - 3y - 2z = 0 \\ x + y = -4 \end{cases}$

11. a. $\begin{bmatrix} -1 & 7 \\ 1 & 4 \end{bmatrix}$

b. $\begin{bmatrix} 1 & 4 \\ 2 & -14 \end{bmatrix}$

13. a. $\begin{bmatrix} 1 & 3 & 7 \\ 4 & -1 & 6 \\ -8 & -2 & 5 \end{bmatrix}$

b. $\begin{bmatrix} 1 & 3 & 7 \\ -16 & 0 & -7 \\ 4 & -1 & 6 \end{bmatrix}$

15. $(-1, 2)$

17. $(-1, -1)$

19. $(-1, -2, 3)$

21. $(1, 0, 1)$

23. $(2, 1, -1)$

25. $(-2, 9, 1)$

27. No solution

29. Infinite number of solutions

31. $(1, -3, 2)$

33. $(0, -4)$

35. $(2, 1, 7)$

37. $(2, -3, 4)$

39. $\left(\frac{13}{12}, \frac{5}{4}, \frac{8}{3}\right)$

Applications

41. 52, 40, 77

43. Bacon: \$3.09/lb; Eggs: \$4.03/doz; Bread: \$1.40/loaf

45. a. $\begin{cases} u + c = 12 \\ 2500u + 625c = 13{,}125 \end{cases}$

b. $\left[\begin{array}{cc|c} 1 & 1 & 12 \\ 2500 & 625 & 13{,}125 \end{array}\right]$

c. University: 3, Community College: 9

Writing & Thinking

47. Solving the second equation for z, we can back substitute into the first equation, eliminating z. The result is the equation $x + 5y = 6$, which means the system has an infinite number of solutions.

9.8 Exercises

Concept Check

1. test-point

3. closed

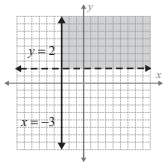
5. three

7. False; When boundary lines are parallel, the solution is either the strip between the boundary lines, a half-plane, or there is no solution.

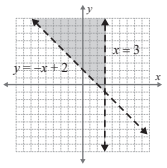
9. True

Practice

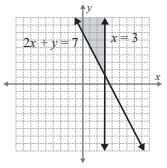
1.



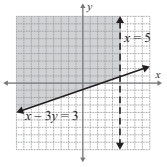
3.



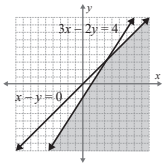
5.



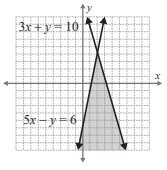
7.



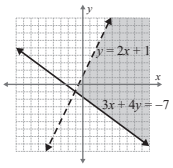
9.



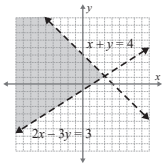
11.



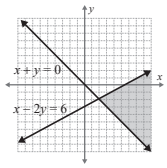
13.



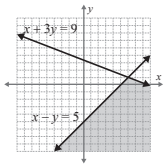
15.



17.

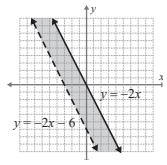


19.

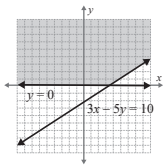


21. No solution

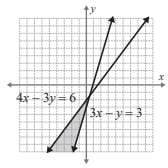
23.



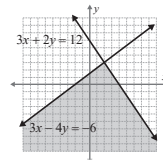
25.



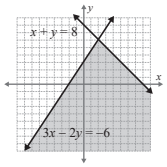
27.



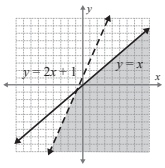
29.



31.



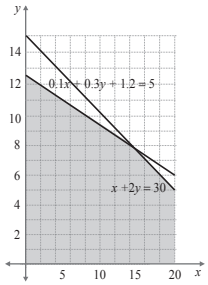
33.



Applications

35. a. $\begin{cases} 0.1x + 0.3y + 1.2 < 5 \\ x + 2y < 30 \end{cases}$

b.

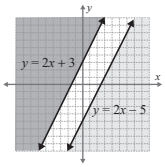


c. Answers will vary.

d. Answers will vary. For example, any negative values of x and y since you cannot have a negative number of cookies.

Writing & Thinking

37. The solutions of the two inequalities do not overlap.



Chapter 10: Exponents and Polynomials

10.1 Exercises

Concept Check

1. subtract

3. positive

5. a

7. False; If there is no exponent written, the exponent is assumed to be 1.

9. True

Practice

1. 27 **3.** 512

5. $\frac{1}{3}$ **7.** $\frac{1}{25}$

9. 16 **11.** 24

13. -500 **15.** $\frac{3}{8}$

17. $-\frac{3}{25}$ **19.** x^5

21. y^2 **23.** $\frac{1}{x^3}$

25. $\frac{2}{x}$ **27.** $-\frac{8}{y^2}$

29. $\frac{5x^6}{y^4}$ **31.** 4

33. 49 **35.** $\frac{1}{10}$

37. $\frac{1}{8}$ **39.** x^2

41. x^2 **43.** x^4

45. $\frac{1}{x^4}$ **47.** x^6

49. x^2 **51.** y^2

53. $3x^3$ **55.** x^4

57. $36x^3$ **59.** $-14x^5$

61. $-12x^6$ **63.** $4y$

65. $3y^2$ **67.** $-2y^2$

69. $\frac{1}{x^2}$ **71.** 1000

73. 1 **75.** $-18x^5y^7$

77. $-\frac{2y^2}{x}$

79. $12a^3b^9c$

81. $-4a^{10}b^3c$

83. $\frac{5}{x}$

85. 1

87. 0.3906

89. 8875.147264

Applications

91. 2^8 GB

93. 10^{-24} cm^3

95. 1 delivery

97. 3^9 square yards

99. **a.** $(2x)^3$

b. Product rule for exponents

c. $8x^3$ **d.** 64 cm^3

101. **a.** $\frac{2^{38}}{230} = 28$ gigabytes

b. 256 gigabytes

c. Quotient rule

10.2 Exercises

Concept Check

1. exponent(s)

3. multiply, keep

5. coefficient

7. True

9. True

Practice

1. -81 **3.** -16

5. 1,000,000 **7.** a^6

9. $\frac{1}{x^{10}}$ **11.** $\frac{1}{256}$

13. $9y^2$ **15.** $16x^2y^2$

17. $\frac{1}{x^6y^6}$ **19.** $36x^6$

21. $-108x^6$ **23.** $\frac{5x^2}{y}$

25. $-\frac{2y^6}{27x^{15}}$ **27.** $\frac{a^4}{b^4}$

29. $\frac{4}{9}$ **31.** $\frac{x^6}{y^6}$

33. $\frac{27x^3}{y^3}$ **35.** 1

37. $4x^4y^4$ **39.** $\frac{y^2}{x^2}$

41. $\frac{1}{3xy^2}$ **43.** $-\frac{x^3y^6}{27}$

45. m^2n^4 **47.** $-\frac{y^2}{49x^2}$

49. $\frac{25x^6}{y^2}$ **51.** $\frac{x^6}{y^6}$

53. $\frac{36y^{14}}{x^4}$ **55.** $\frac{49y^4}{x^6}$

57. $\frac{24y^5}{x^7}$ **59.** $\frac{4x^3}{3}$

61. $\frac{16x^{13}}{243y^6}$ **63.** $96x^2y^4z^4$

65. 19.4481 **67.** $208.5136x^4$

69. 22.7024

10.3 Exercises

Concept Check

1. 1, 10

3. decimal point

5. False; The decimal point should be moved 3 places to the left.

7. False; 4000 written in scientific notation is 4.0×10^3.

Practice

1. 8.6×10^4

3. 3.62×10^{-2}

5. 1.83×10^7

7. 2.368×10^{-10}

9. 9×10^{-7}

11. 3.28×10^{-11}

13. 0.042

15. 7,560,000

17. 0.00006132

19. 30,670,000,000

21. 7,205,000,000

23. 0.00000691

25. $(3\times10^2)(1.5\times10^{-4})$; 4.5×10^{-2}

27. $(3\times10^{-4})(2.5\times10^{-6})$; 7.5×10^{-10}

29. $(2.34\times10^{10})(5.5\times10^9)$; 1.287×10^{20}

31. $\frac{3.9\times10^3}{3\times10^{-3}}$; 1.3×10^6

33. $\frac{1.25\times10^2}{5\times10^4}$; 2.5×10^{-3}

35. $\frac{1.3\times10^{-12}}{2.6\times10^{-8}}$; 5×10^{-5}

37. $\frac{(8.4\times10^{-3})(3\times10^{-3})}{(2.1\times10^{-1})(6\times10)}$; 2×10^{-6}

39. $\frac{(5.4\times10^0)(3\times10^{-3})(5\times10)}{(1.5\times10)(2.7\times10^{-3})(2\times10^2)}$; 1×10^{-1}

41. $\frac{(1.4\times10^{-2})(9.22\times10^2)}{(3.5\times10^3)(2.0\times10^6)}$; 1.844×10^{-9}

43. $\frac{(2.5\times10)(3.75\times10^{-5})}{(4\times10^{10})(7.5\times10^{-6})}$; 3.125×10^{-9}

45. $\frac{(1.4\times10^{-7})(7\times10^{13})}{4\times10}$; 2.45×10^5

47. $\frac{(1.95\times10^{-5})(2.65\times10^3)(7.56\times10^{10})}{(1.5\times10^7)(1.3\times10^{-13})}$; 2.0034×10^{15}

49. 3E8

51. 8.5E7

53. 3E22

55. 1.6051E15

57. 1E2

59. 1.02E22

Applications

61. 1.67×10^{-24} grams

63. 60,000,000,000,000 cells

65. 5.98×10^{27} grams

67. 4.0678×10^{16} m

69. 6.5×10^{-19} grams

71. No. Should be 5.2×10^5

10.4 Exercises

Concept Check

1. descending

3. leading

5. binomial

7. False; Degree of 0

9. True

Practice

1. Monomial

3. Binomial

5. Trinomial

7. Not a polynomial

9. Binomial

11. $4y$; First-degree monomial; Leading coefficient 4

13. x^3+3x^2-2x; Third-degree trinomial; Leading coefficient 1

15. $-2x^2$; Second-degree monomial; Leading coefficient -2

17. 0; Monomial of no degree; Leading coefficient 0

19. $6a^5-7a^3-a^2$; Fifth-degree trinomial; Leading coefficient 6

21. $2y^3+4y$; Third-degree binomial; Leading coefficient 2

23. 4; Monomial of degree 0; Leading coefficient 4

25. $2x^3+3x^2-x+1$; Third-degree polynomial; Leading coefficient 2

27. $4x^4-x^2+4x-10$; Fourth-degree polynomial; Leading coefficient 4

29. $9x^3+4x^2+8x$; Third-degree trinomial; Leading coefficient 9

31. **a.** -4 **b.** -16 **c.** -10

33. -16

35. -41

37. 4379

39. 13

41. -28

43. $3a^4+5a^3-8a^2-9a$

45. $3a+11$

47. $10a+25$

Applications

49. **a.** First degree polynomial

b. 5 feet per second

c. 50 feet per second

d. 95 feet per second

51. **a.** First degree polynomial

b. 9 games **c.** 11 games

d. 29 games

53. **a.** \$20,250 **b.** \$16,000

55. **a.** 12 feet **b.** 28 feet

c. 72 feet

d. No. Answers will vary.

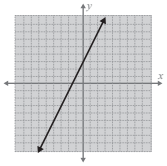
57. \$45,950 in 2020; \$24,950 in 2026

59. 61 after 4 hours; 250,122 after 2 days (48 hours)

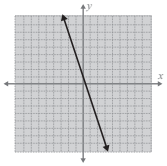
Writing & Thinking

61. He was correct. The expression is a sum/difference of monomials.

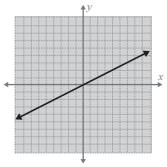
63. **a.**



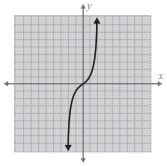
b.



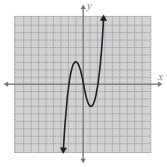
c.



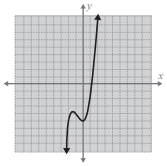
65. **a.**



b.



c.



10.5 Exercises

Concept Check

1. sign

3. like

5. variables

7. False; All terms are subtracted.

9. False; They are like terms because they have the same variable raised to the same exponent.

Practice

1. $3x^2+7x+2$

3. $2x^2+11x-7$

5. $3x^2$

7. $x^2-5x+17$

9. $-x^2+2x-7$

11. $2x^3+4x^2-3x-7$

13. $-x^2+7x-3$

15. $-x^3+2x^2+3x-4$

17. $4x^3+7$

19. $2x^3+11x^2-4x-3$

21. x^2+x+6

23. $-3x^2-6x-2$

25. $3x^2-4x-8$

27. $-x^4-2x^3-16$

29. $-4x^4-7x^3-11x^2+5x+13$

31. $-4x^2+6x+1$

33. $3x^4-7x^3+3x^2-5x+9$

35. $6x^2-7x+18$

37. $8x^4+6x^2+15$

39. $2x^3+4x^2+3x-10$

41. $4x-13$

43. $-7x+9$

45. $2x+17$

47. $3x^3+13x^2+9$

49. $8x^2-x-2$

51. $3x-19$

53. $x^2-2x+13$

55. $7x-3$

57. $4x^2+3x+5$

59. $7x-18$

61. $x^2+11x-8$

63. $7x^3-x^2-7$

Applications

65. **a.** $3.50x^3+4x^2-30$ dollars

b. $6.50x^3+4x^2-20$ dollars

c. \$460

Writing & Thinking

67. Add the opposite of each term in the polynomial being subtracted to the original polynomial and combine like terms.

10.6 Exercises

Concept Check

1. distributive

3. FOIL

5. like

7. False; The product of $(a+b)$ and $(c+d)$ is $ac+ad+bc+bd$.

Practice

1. $-6x^5-15x^3$

3. $4x^7-12x^6+4x^5$

5. $-y^5+8y-2$

7. $-4x^8+8x^7-12x^4$

9. $25x^5-5x^4+10x^3$

11. $a^7+2a^6-5a^3+a^2$

13. x^2+x-12

15. $a^2-2a-48$

17. x^2-3x+2

19. $3t^2-3t-60$

21. x^3+11x^2+24x

23. $2x^2-7x-4$

25. $6x^2+17x-3$

27. $4x^2-9$

29. $16x^2+8x+1$

31. y^3+2y^2+y+12

33. $3x^2-8x-35$

35. $5x^3+6x^2-22x-9$

37. $2x^4+7x^3+5x^2+x-15$

39. $3x^2+2x-8$

41. $2x^2+3x-5$

43. $7x^2-13x-2$

45. $6x^2-13x-8$

47. $4x^2+12x+9$

49. $x^3+3x^2-4x-12$

51. $4x^2-49$

53. x^3+1

55. $49a^2-28a+4$

57. x^3+8x^2+15x

59. $6x^3-2x^2-4x$

61. $2x^3+x^2-5x-3$

63. $x^3+6x^2+11x+6$

65. a^4-a^2+2a-1

67. $t^4+6t^3+13t^2+12t+4$

69. $6x^2-x-2$

71. $9a^2-25$

73. $-10x^2+39x-14$

75. x^3+5x^2+8x+4

77. $2y^2-61$

79. $3a^2-17a+11$

81. $-3x-21$

83. a^2+9a-1

Applications

85. $6x^2+15x$ square inches

87. $R(x)=-8x^2+70x+1500$

89. **a.** $A(x)=280-4x^2$

b. $14-2x$ and $20-2x$

c. $B(x)=4x^2-68x+280$

d. $V(x)=4x^3-68x^2+280x$

Writing & Thinking

91. **a.** Answers will vary.

b. Answers will vary.

10.7 Exercises

Concept Check

1. difference

3. trinomial

5. False; The product will be a binomial.

7. True

Practice

1. $x^2 - 14x + 49$; Perfect square trinomial

3. $x^2 + 8x + 16$; Perfect square trinomial

5. $x^2 - 9$; Difference of two squares

7. $x^2 - 81$; Difference of two squares

9. $2x^2 + x - 3$

11. $9x^2 - 24x + 16$; Perfect square trinomial

13. $25x^2 - 4$; Difference of two squares

15. $9x^2 - 12x + 4$; Perfect square trinomial

17. $x^2 - 16x + 64$; Perfect square trinomial

19. $16x^2 - 25$; Difference of two squares

21. $25x^2 - 81$; Difference of two squares

23. $x^2 - 8x + 16$; Perfect square trinomial

25. $4x^2 - 49$; Difference of two squares

27. $10x^4 - 11x^2 - 6$

29. $49x^2 + 14x + 1$; Perfect square trinomial

31. $x^2 + 10x + 25$

33. $x^4 - 1$

35. $x^4 + 6x^2 + 9$

37. $x^6 - 4x^3 + 4$

39. $9x^2 - 4$

41. $16x^2 - 9$

43. $25x^2 + 30x + 9$

45. $36x^2 - 60x + 25$

47. $x^2 - 1.96$

49. $x^2 - 5x + 6.25$

51. $x^2 - 4.6225$

53. $x^2 + 2.48x + 1.5376$

55. $2.0164x^2 + 27.264x + 92.16$

57. $129.96x^2 - 12.25$

59. $93.24x^2 + 142.46x - 104.04$

Applications

61. **a.** $A(x) = 900 - 4x^2$

b. $P(x) = 4(30 - 2x) + 8x = 120$

63. **a.** $f(x) = 15x^6 - 30x^5 + 15x^4$

b. 0.234375

65. **a.** $A(x) = 150 - 4x^2$

b. $P(x) = 2(15 - 2x) + 2(10 - 2x) + 8x = 50$

c. $V(x) = (10 - 2x)(15 - 2x)x = 4x^3 - 50x^2 + 150x$

67. **a.** $A(x) = 400 - 4x^2$

b. $20 - 2x$ and $20 - 2x$

c. $B(x) = 400 - 80x + 4x^2$

d. $V(\mathrm{I}) = 400x - 80x^2 + 4x^3$

10.8 Exercises

Concept Check

1. rational

3. numerator, simplify

5. 0

7. False; Descending order

9. True

Practice

1. $y^2 - 2y + 3$

3. $2x^2 - 3x + 1$

5. $10x^3 - 11x^2 + x$

7. $-4x^2 + 7x - \frac{5}{2}$

9. $y^3 - \frac{7}{2}y^2 - \frac{15}{2}y + 4$

11. $x - 6 + \frac{4}{x+4}$

13. $3x - 4 - \frac{7}{2x-1}$

15. $3x + 4 + \frac{1}{7x-1}$

17. $x - 9$

19. $x^2 - x - \frac{3}{x-8}$

21. $4x^2 - 6x + 9 - \frac{17}{x+2}$

23. $x^2 + 7x + 55 + \frac{388}{x-7}$

25. $2x^2 - 9x + 18 - \frac{30}{x+2}$

27. $7x^2 + 2x + 1$

29. $x^2 + 2x + 2 - \frac{12}{2x+3}$

31. $x^2 + 3x + 2 - \frac{2}{x-4}$

33. $2x^2 + x - 3 + \frac{18}{5x+3}$

35. $2x^2 - 8x + 25 - \frac{98}{x+4}$

37. $3x^2 + 2x - 5 - \frac{1}{3x-2}$

39. $3x^2 - 2x + 5$

41. $x^3 + 2x + 5 + \frac{17}{x-3}$

43. $x^3 + 2x^2 + 6x + 9 + \frac{23}{x-2}$

45. $x^3 + \frac{1}{2}x^2 - \frac{3}{4}x - \frac{3}{8} + \frac{45}{16\left(x - \frac{1}{2}\right)}$

47. $3x + 5 + \frac{x-1}{x^2+2}$

49. $x^2 + x - 4 + \frac{-8x+17}{x^2+4}$

51. $2x + 3 + \frac{6}{3x^2 - 2x - 1}$

53. $3x^2 - 10x + 12 + \frac{-x-14}{x^2+x+1}$

55. $x^2 - 2x + 7 + \frac{-17x+14}{x^2+2x-3}$

57. $x^2 + 3x + 9$

59. $x^5 - x^4 + x^3 - x^2 + x - 1$

61. $x^4 + x^3 + x^2 + x + 1 + \frac{2}{x-1}$

63. $x^4 - \frac{1}{2}x^3 - \frac{3}{4}x^2 + \frac{3}{8}x + \frac{13}{16} - \frac{13}{32\left(x + \frac{1}{2}\right)}$

Applications

65. **a.** $x^2 - 4x - 5$ square inches

b. $x^2 - 3x - 10$ square inches

Writing & Thinking

67. $3x^3 + 4x^2 + 8x + 12$; Multiply the divisor $(3x - 2)$ by the quotient, $x^2 + 2x + 4 + \frac{20}{3x-2}$, to get the original polynomial.

69. **a.** 19; $2x^2 - 4x + 2 + \frac{19}{x-2}$

b. -5; $2x^2 - 10x + 20 - \frac{5}{x+1}$

c. 55; $2x^2 + 10 + \frac{55}{x-4}$ Yes; $R = P(a)$ when $P(x)$ is divided by x.

10.9 Exercises

Concept Check

1. binomial

3. remainder

5. one

7. True

9. True

Practice

1. **a.** $x - 9$

b. $c = 3$; $P(3) = 0$

3. **a.** $x^2 - 4x + 33 - \frac{265}{x+8}$

b. $c = -8$; $P(-8) = -265$

5. **a.** $4x^2 - 6x + 9 - \frac{17}{x+2}$

b. $c = -2$; $P(-2) = -17$

7. **a.** $x^2 + 7x + 55 + \frac{388}{x-7}$

b. $c = 7$; $P(7) = 388$

9. **a.** $2x^2 - 2x + 6 - \frac{27}{x+3}$

b. $c = -3$; $P(-3) = -27$

11. **a.** $x^3 + 2x + 5 + \frac{17}{x-3}$

b. $c = 3$; $P(3) = 17$

13. **a.** $x^3+2x^2+6x+9+\dfrac{23}{x-2}$

b. $c=2;\ P(2)=23$

15. **a.** $x^3+\dfrac{1}{2}x^2-\dfrac{3}{4}x-\dfrac{3}{8}+\dfrac{45}{16\left(x-\frac{1}{2}\right)}$

b. $c=\dfrac{1}{2};P\left(\dfrac{1}{2}\right)=\dfrac{45}{16}$

17. **a.** $x^4+x^3+x^2+x+1$

b. $c=1;\ P(1)=0$

19. **a.** $x^3-\dfrac{14}{5}x^2+\dfrac{56}{25}x-\dfrac{224}{125}+\dfrac{3396}{625\left(x+\frac{4}{5}\right)}$

b. $c=-\dfrac{4}{5};P\left(-\dfrac{4}{5}\right)=\dfrac{3396}{625}$

Applications

21. 41 °F

Collaborative Learning

23. **a.** Answers will vary.

$x^2-\dfrac{7}{2}x+\dfrac{13}{4}+\dfrac{73}{4(2x-1)}$;

$2x^2-7x+\dfrac{13}{2}+\dfrac{73}{4\left(x-\frac{1}{2}\right)}$

b. $\dfrac{P(x)}{x-\frac{b}{a}}=\dfrac{aP(x)}{ax-b}$

c. If a polynomial $P(x)$ is divided by $(ax-b)$, then the remainder will be $P\left(\dfrac{b}{a}\right)$. Answers will vary.

Chapter 11: Factoring Polynomials

11.1 Exercises

Concept Check

1. product, factors

3. greatest common factor, largest

5. negative / opposite

7. True

9. False; Binomials can be common factors.

Practice

1. 5 **3.** 8

5. 1 **7.** $10x^3$

9. $4a^2$ **11.** $13ab$

13. $15xy^2z^2$ **15.** x^4

17. $-4y$ **19.** $3x^3$

21. $2x^2y$ **23.** $m+9$

25. $x-6$ **27.** $b+1$

29. $3y+4x+1$

31. $11(x-11)$

33. $4y(4y^2+3)$

35. $-3a(2x-3y)$

37. $5xy(2x-5)$

39. $-2yz(9yz-1)$

41. $8(y^2-4y+1)$

43. $x(2y^2-3y-1)$

45. $4m^2(2x^3-3y+z)$

47. $-7x^2z^3(8x^2+14xz+5z^2)$

49. $x^4y^2(15+24x^2y^4-32x^3y)$

51. $(y+3)(7y^2+2)$

53. $(x-4)(3x+1)$

55. $(x-2)(4x^3-1)$

57. $(2y+3)(10y-7)$

59. $(x-2)(a-b)$

61. $(b+c)(x+1)$

63. $(x^2+6)(x+3)$

65. Not factorable

67. $(3-b)(x+y)$

69. $(y-4)(5x+z)$

71. $(z^2+3)(a+1)$

73. $(6x+1)(a+2)$

75. $(x+1)(y+1)$

77. $(2y-7z)(5x-y)$

79. $(3x-4u)(y-2v)$

81. Not factorable

83. $(2c-3d)(3a+b)$

Applications

85. She can make 30 identical treat bags, each containing 5 pieces of candy A, 6 pieces of candy B, and 11 pieces of candy C.

87. **a.** 32 feet **b.** $16x(3-x)$

c. 32 feet

d. Yes. They are equivalent expressions.

11.2 Exercises

Concept Check

1. constant, middle

3. positive

5. different

7. False; One factor is negative, one is positive.

9. True

Practice

1. $\{1,15\},\{-1,-15\},\{3,5\},\{-3,-5\}$

3. $\{1,20\},\{-1,-20\},\{4,5\},\{-4,-5\},\{2,10\},\{-2,-10\}$

5. $\{1,-6\},\{6,-1\},\{2,-3\},\{3,-2\}$

7. $\{1,16\},\{-1,-16\},\{4,4\},\{-4,-4\},\{8,2\},\{-8,-2\}$

9. $\{1,-10\},\{10,-1\},\{5,-2\},\{2,-5\}$

11. 4, 3

13. −7, 2

15. 8, −1

17. −6, −6

19. −5, −4

21. $x+1$

23. $p-10$

25. $a+6$

27. $(x-4)(x+3)$

29. $(y+6)(y-5)$

31. Not factorable

33. $(x-4)(x-4)$

35. $(x+4)(x+3)$

37. $(y-1)(y-2)$

39. Not factorable

41. $(x+8)(x-9)$

43. $(z-6)(z-9)$

45. $x(x+7)(x+3)$

47. $5(x-4)(x+3)$

49. $10y(y-3)(y+2)$

51. $4p^2(p+1)(p+8)$

53. $2x^2(x-9)(x+2)$

55. $2(x^2-x-36)$

57. $2a^2(a-10)(a+6)$

59. $3y^3(y-8)(y+1)$

61. $x(x-2)(x-8)$

63. $5(a^2+2a-6)$

65. $20a^2(a+1)(a+1)$

Applications

67. Base = $x+48$; Height = x

69. $x+5$

71. **a.** 0 feet

b. $-16(t-3)(t+2)$

c. 0 feet

d. Yes. They are equivalent expressions.

Writing & Thinking

73. If the sign of the constant term is positive, the signs in the factors will both be positive or both be negative. If the sign of the constant term is negative, the sign in one factor will

be positive and the sign in the other factor will be negative.

11.3 Exercises

Concept Check

1. factors
3. factorable
5. product, sum
7. False; The middle term should be the sum of the inner and outer products.
9. False; The first step is to multiply a and c.

Practice

1. $(x+2)(x+3)$
3. $(2x-5)(x+1)$
5. $(6x+5)(x+1)$
7. $-(x-2)(x-1)$
9. $(x-5)(x+2)$
11. $-(x-14)(x+1)$
13. Not factorable
15. $-x(2x+1)(x-1)$
17. $(t-1)(4t+1)$
19. $(5a-6)(a+1)$
21. $(7x-2)(x+1)$
23. $(2x-3)(4x+1)$
25. $(3x+4)(3x-5)$
27. $2(2x-5)(3x-2)$
29. $(3x-1)(x-2)$
31. $(3x-1)(3x-1)$
33. $(3y+2)(2y+1)$
35. $(x-1)(x-45)$
37. Not factorable
39. $2b(4a-3)(a-2)$
41. Not factorable
43. $(4x-1)(4x-1)$
45. $(8x-3)(8x-3)$
47. $2(3x-5)(x+2)$
49. $5(2x+3)(x+2)$
51. $-2(9x^2-36x+4)$
53. $-15(3y+4)(y-2)$
55. $3(2x-5)(2x-5)$
57. $3x(2x-1)(x+2)$
59. $3x(2x-9)(2x-9)$
61. $9xy^3(x^2+x+1)$
63. $4xy(3y-4)(4y-3)$
65. $7y^2(y-4)(3y-2)$

Writing & Thinking

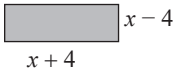
67. This is not an error, but the trinomial is not completely factored. The completely factored form of this trinomial is $2(x+2)(x+3)$.
69. $x(5-2x)(25-2x)$; The height is x, the width is $(5-2x)$, and the length is $(25-2x)$.

11.4 Exercises

Concept Check

1. binomial
3. $2ax$, $-2ax$
5. $(x+a)(x^2-ax+a^2)$
7. True
9. False; The sum of two squares is not factorable.

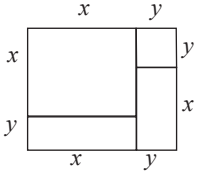
Practice

1. $(x-5)(x+5)$
3. $(9-y)(9+y)$
5. $2(x-8)(x+8)$
7. $4(x-2)(x+2)(x^2+4)$
9. Not factorable
11. $(y-8)^2$
13. $-4(x-5)(x+5)$
15. $(3x-5)(3x+5)$
17. $(y-5)^2$
19. $(2x-1)^2$
21. $(5x+3)^2$
23. $(4x-5)^2$
25. $4x(x-4)(x+4)$
27. $2xy(x+8)^2$
29. $(y+3)^2$
31. $(x-10)^2$
33. $(x^2+5y)^2$
35. $(x-5)(x^2+5x+25)$
37. $(y+6)(y^2-6y+36)$
39. $(x+3y)(x^2-3xy+9y^2)$
41. Not factorable
43. $4(x-2)(x^2+2x+4)$
45. $2(3x-y)(9x^2+3xy+y^2)$
47. $y(x+y)(x^2-xy+y^2)$
49. $x^2y^2(1-y)(1+y+y^2)$
51. $3xy(2x+3y)(4x^2-6xy+9y^2)$
53. $(x^2-y^3)(x^4+x^2y^3+y^6)$
55. $(3x+y^2)(9x^2-3xy^2+y^4)$
57. $(2x+y)(4x^2-2xy+y^2)$
59. $8(y-1)(y^2+y+1)$
61. $(3x-y)(3x+y)$
63. $(x-2y)(x+2y)(x^2+4y^2)$
65. $(x-y-9)(x-y+9)$
67. $(x-y-6)(x-y+6)$
69. $(4x+1-y)(4x+1+y)$
71. **a.** x^2-16
    b. 

Writing & Thinking

73. **a.** $xy+xy+x^2+y^2$
$=x^2+2xy+y^2$
$=(x+y)^2$

b. $(x+y)(x+y)$
$=(x+y)^2$



75. For a 3-digit integer:
abc
$=100a+10b+c$
$=(99+1)a+(9+1)b+c$
$=9(11a+b)+a+b+c$
So, if the sum $(a+b+c)$ is divisible by 3 (or 9), then the number abc will be divisible by 3 (or 9).

For a 4-digit integer:
$abcd$
$=1000a+100b+10c+d$
$=(999+1)a+(99+1)b$
$+(9+1)c+d$
$=9(111a+11b+c)+a$
$+b+c+d$
So, if the sum $(a+b+c+d)$ is divisible by 3 (or 9), then the number $abcd$ will be divisible by 3 (or 9).

11.5 Exercises

Concept Check

1. trial-and-error, ac
3. original
5. monomial
7. True

Practice

1. $(m+6)(m+1)$
3. $(x+9)(x+2)$
5. $(x-10)(x+10)$
7. $(m-3)(m+2)$
9. Not factorable
11. $(8a-1)(8a+1)$
13. $(x+5)^2$
15. $(x+12)(x-3)$
17. $3(a+6)(a-2)$
19. $-5(x-6)(x-8)$
21. Not factorable
23. $x(x-6)(x+2)$
25. $-2a(a+8)(a-7)$
27. $4x(2x-5)(2x+5)$
29. $-(x-5)(3x-2)$

31. $(2x-1)(3x-4)$
33. $(4m+3)(3m-2)$
35. $2(2x-1)(x-3)$
37. $(4x-7)(2x+5)$
39. $(5x+6)(4x-9)$
41. $-(5x-7)(3x+2)$
43. $-(2a-3)(4a-5)$
45. $(4y+5)(5y-4)$
47. $(6x-1)(3x-2)$
49. $-6(5x-4)(5x+4)$
51. $3(4n^2-20n-25)$
53. $a(21a^2-13a-2)$
55. $3x(3x-2)(4x+5)$
57. $2x(2x-1)(4x-11)$
59. $5(24m^2+2m+15)$
61. $(y-4)(x+3)$
63. $(x+2y)(x-6)$
65. $-(x^2-5)(x-8)$
67. $(x+5)(x^2-5x+25)$
69. $x^4(y-1)(y^2+y+1)$
71. $(2a^2+3b^2)$
$(4a^4-6a^2b^2+9b^4)$
73. (x^2y-5)
$(x^4y^2+5x^2y+25)$
75. $(x-3)(x+3)(x+7)$
77. $(3x+y+6)(3x-y-6)$
79. $(y+10+7x)(y+10-7x)$

11.6 Exercises

Concept Check

1. zero
3. factor
5. substituting
7. True
9. True

Practice

1. $x=2, 3$
3. $x=-2, \frac{9}{2}$
5. $x=-3$
7. $x=-5$
9. $x=0, 2$
11. $x=-6$
13. $x=-1, 4$
15. $x=-3, 4$
17. $x=-3, 0$
19. $x=2, 4$
21. $x=-4, 3$
23. $x=-\frac{1}{2}, 3$
25. $x=-\frac{2}{3}, 2$
27. $x=-\frac{1}{2}, 4$
29. $x=-2, \frac{4}{3}$
31. $x=\frac{3}{2}$
33. $x=0, \frac{8}{5}$
35. $x=-2, 2$
37. $x=1$
39. $x=2$
41. $x=-3, 3$
43. $x=-5, 10$
45. $x=-6, -2$
47. $x=\frac{1}{2}$
49. $x=0, 2, 4$
51. $x=-\frac{2}{3}, -\frac{1}{2}, 0$
53. $x=-10, 10$
55. $x=-5, 5$
57. $x=-4$
59. $x=3$
61. $x=-1, 3$
63. $x=-8, -2$
65. $x=-5, 2$
67. $x=-5, 7$
69. $x=-6, 2$
71. $x=-1, \frac{2}{3}$
73. $x=-\frac{3}{2}, 4$
75. $y^2-y-6=0$
77. $2x^2+11x+5=0$
79. $8x^2-10x+3=0$
81. $x^3-x^2-6x=0$
83. $y^3-4y^2-3y+18=0$

Applications

85. **a.** 640 ft; 384 ft
b. 144 ft; 400 ft
c. 7 seconds; $0=-16(t+7)(t-7)$
87. **a.** The ball will hit the ground.
b. $0=-16t^2+16t+96$
c. $t=-2, 3$
d. The ball will hit the ground after −2 seconds and after 3 seconds.
e. No, time cannot be negative.
89. **a.** π in.^{2} **b.** 4π in.^{2}
c. 16π in.^{2} **d.** 64π in.^{2}
e. The area gets 4 times larger.

Writing & Thinking

91. This allows for use of the zero-factor law which says that for the product to equal zero one of the factors must equal zero. Answers will vary.

11.7 Exercises

Concept Check

1. variable, unknown
3. consecutive
5. 1
7. False; The sum of the squares of the lengths of the legs is equal to the hypotenuse squared.
9. False: Only with right triangles

Applications

1. $x(x+8)=-16$; $x=-4$, so the numbers are −4 and 4.
3. $x^2=7x$; $x=0, 7$
5. $x^2+3x=28$; $x=4$
7. $x(x+3)=40$; $x=-8, 5$, so the numbers are −8 and −5 or 5 and 8.
9. $(x+5)^2+x^2=53$; $x=2$, so the numbers are 2 and 7.
11. $x+(x+4)^2=38$; $x=2$, so the integers are 2 and 6.
13. $x(2x-5)=x+56$; $x=-4$
15. $x(x+1)=72$; $x=8$, so the integers are 8 and 9.
17. $x^2+(x+1)^2=85$; $x=6$, so the integers are 6 and 7.
19. $x(x+2)=63$; $x=-9, 7$, so the integers are −9 and −7 or 7 and 9.
21. $4x+(x+1)^2=41$; $x=4$, so the integers are 4 and 5.
23. $2x(x+1)$
$=(x+1)(x+2)+88$;
$x=10$, so the integers are 10, 11, and 12.
25. $6x(x+2)$
$=(x+1)+(x+3)^2$;
$x=-2, 1$, so the integers are −2, −1, 0, and 1 or 1, 2, 3, and 4.
27. $w(2w)=72$; $w=6$, so width is 6 in. and length is 12 in.
29. $w(4w)=64$; $w=4$, so width is 4 ft and length is 16 ft.
31. $l(l-4)=45$; $l=9$, so width is 5 ft and length is 9 ft.
33. $\frac{1}{2}b(b-4)=16$; $b=8$, so base is 8 ft and height is 4 ft.
35. $\frac{1}{2}(h+6)h=20$; $h=4$, so the base is 10 in.
37. $w(16-w)=48$; $w=4$, 12, so the rectangle is 4 in. by 12 in.

39. $r(r+13)=140$; $r=7$, so there are 7 trees in each row.

41. $r(r+7)=144$; $r=9$, so there are 9 rows.

43. $n(n+1675)=8400$; $n=5$, so there are 5 floors.

45. $(w+11)(w+4)=98$; $w=3$, so the rectangle was 3 cm by 10 cm.

47. $w=10, 15$, so width is 10 ft and length is 30 ft or width is 15 ft and length is 20 ft.

49. $h^2+(h-34)^2=(h+2)^2$; $h=48$, so the height of the pole is 48 ft.

51. $x^2+(x-49)^2=(x+1)^2$; $x=60$, so height is 60 ft.

53. $l^2+(l-28)^2=(l+8)^2$; $l=60$, so the length of the mat is 60 inches.

55. **a.** Figures will vary.

b. $(17-x)^2+x^2=13^2$

c. $x=12, x=5$ **d.** Yes

e. The wire is attached to the pole 5 feet from the ground (12 feet from the top) and attached to the stake which is 12 feet from the pole. Or the wire is attached to the pole 12 feet from the ground (5 feet from the top) and attached to the stake which is 5 feet from the pole.

f. Answers will vary.

57. \$1.50 per pound

59. \$16 or \$20 per reel

Writing & Thinking

61. 128 in.^{2}; We can use the Pythagorean Theorem to find the length and the width (by finding the diagonals of the interior square) instead.

Chapter 12: Rational Expressions

12.1 Exercises

Concept Check

1. rational

3. fundamental

5. fractions

7. True

9. False; Rational numbers cannot have zero denominators.

Practice

1. $\frac{3x}{4y}; x\neq 0, y\neq 0$

3. $\frac{2x^3}{3y^3}; x\neq 0, y\neq 0$

5. $\frac{1}{x-3}; x\neq 0,3$

7. $7; x\neq 2$

9. $-\frac{3}{4}; x\neq 3$

11. $\frac{2x}{y}; x\neq -\frac{2}{3}, y\neq 0$

13. $\frac{x}{x-1}; x\neq -6, 1$

15. $\frac{x-7}{x-3}; x\neq -3,3$

17. $\frac{x-3}{y-2}; y\neq -2,2$

19. $\frac{x+7}{y+5}; x\neq 2, y\neq -5$

21. $\frac{2}{75}$

23. 9

25. 0

27. $\frac{-3}{32}$

29. 1

Applications

31. **a.** $p(x)=\frac{15x+200}{x}$

b. \$35 **c.** $x\neq 0$

d. The variable cannot be negative because you cannot have a negative quantity of people. There would also be a maximum number depending on the size of the room.

33. **a.** \$11.62 **b.** \$6.29

c. \$5.33

d. The cost per calculator decreases as the number of calculators purchased increases.

e. $x\neq -20$

f. The value of x cannot be negative because you cannot buy a negative quantity of calculators

35. $(2x-5)$ feet

Writing & Thinking

37. **a.** A rational expression is an algebraic expression that can be written in the form $\frac{P}{Q}$ where P and Q are polynomials and $Q\neq 0$.

b. $\frac{x-1}{(x+2)(x-3)}$
Answers will vary.

c. $\frac{1}{x+5}$
Answers will vary.

12.2 Exercises

Concept Check

1. factor

3. numerator, denominator

5. numerators, denominators

7. True

9. False; the restriction is 0.

Practice

1. $\frac{ab}{6y}$

3. $\frac{8x^2y^3}{15}$

5. $\frac{x+3}{x}$

7. $\frac{x-1}{x+1}$

9. $-\frac{1}{x-8}$

11. $\frac{x-2}{x}$

13. $\frac{4x+20}{x(x+1)}$

15. $\frac{x}{(x+3)(x-1)}$

17. $-\frac{x+4}{x(x+1)}$

19. $\frac{x+2y}{(x-3y)(x-2y)}$

21. $\frac{x-1}{x(2x-1)}$

23. $\frac{1}{x+1}$

25. $\frac{x+2}{x-2}$

27. $\frac{1}{3xy^6}$

29. $\frac{6y^7}{x^4}$

31. $\frac{x}{12}$

33. $\frac{6x+18}{x^2}$

35. $\frac{6}{5x}$

37. $\frac{3x+1}{x+1}$

39. $\frac{x-2}{2x-1}$

41. $-\frac{x+4}{x(2x-1)}$

43. $\frac{x+1}{x-1}$

45. $\frac{6x^3-x^2+1}{x^2(4x-3)(x-1)}$

47. $\frac{x^2+4x+4}{x^2(2x-5)}$

49. $\frac{x^2-6x+5}{(x-7)(x-2)(x+7)}$

51. $\frac{x^2-3x}{(x-1)^2}$

53. $\frac{x^2+5x}{2x+1}$

55. 1

Applications

57. **a.** $\frac{x^2-3x-10}{x+3}$

b. $\frac{x^2+5x+6}{x-5}$

c. $(x+2)^2 = x^2+4x+4$

12.3 Exercises

Concept Check

1. smallest

3. prime factorization

5. equivalent

7. True

9. False; You completely factor each polynomial, including prime factors for numerical terms.

Practice

1. 150 **3.** 432

5. 600 **7.** 60

9. $\frac{11}{17}$ **11.** $\frac{3}{2}$

13. $\frac{6}{5}$ **15.** $\frac{23}{30}$

17. $\frac{28}{27}$

19. $7(x+5)(x-5)$

21. $30(y-4)$

23. $(x+3)(x-3)(x-3)$

25. $-(y-3)$

27. $-2(x+12)(x-12)$

29. $(x+4)(x-3)(x+5)$

31. $(x-2)(y+3)(x+7)$

33. $2(x+6)(x-6)(x+3)$

35. $6(x-5)(y+6)(y+1)$

37. $(x+2)(x-2)(x^2+4)$

39. 28

41. $33(x-3)$

43. $-3x^2$

45. $2(y+3)(y-1)$
$= 2y^2+4y-6$

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

12.4 Exercises

Concept Check

1. numerator, denominator

3. most

5. equivalent

7. True

9. True

Practice

1. 3

3. 2

5. 1

7. $\frac{2}{x-1}$

9. $\frac{14}{7-x}$

11. 4

13. $\frac{x^2-x+1}{(x+4)(x-3)}$

15. $\frac{x-2}{x+2}$

17. $\frac{4x+5}{2(7x-2)}$

19. $\frac{6x+15}{(x+3)(x-3)}$

21. $\frac{x^2-2x+4}{(x+2)(x-1)}$

23. $\frac{-x^2-3x-6}{(x+3)(3-x)}$

25. $\frac{8x^2+13x-21}{6(x+3)(x-3)}$

27. $\frac{3x^2-20x}{(x+6)(x-6)}$

29. $\frac{-4x}{x-7}$

31. $\frac{4x^2-x-12}{(x+7)(x-4)(x-1)}$

33. $\frac{x-6}{(x-10)(x-8)}$

35. $\frac{6x}{(x-1)(x-7)}$

37. $\frac{4x-19}{(7x+4)(x-1)(x+2)}$

39. $\frac{-7x-9}{(4x+3)(x-2)}$

41. $\frac{4x^2-41x+3}{(x+4)(x-4)}$

43. $\frac{x-4}{2(x-2)}$

45. $\frac{x^2-4x-6}{(x+2)(x-2)(x-1)}$

47. $\frac{3x^2+26x-3}{(x+7)(x-3)(x+1)}$

49. $\frac{6x+2}{(x-1)(x+3)}$

51. $\frac{2x^2+x-4}{(x-2)(y+1)(x+1)}$

53. $\frac{2x+4xy-15y}{(x+3)(y+2)(x-5)}$

55. $\frac{-2x+2}{2x-1}$

57. $\frac{2x^2-x-5}{(x-3)(x+3)(x^2+1)}$

59. $\frac{x^2+9x+6}{(3x+1)(x+3)(x-1)}$

Applications

61. **a.** $\frac{7x^2+3}{x-2}$ **b.** $\frac{4x^2+5}{x+2}$

c. $\frac{22x^3+12x^2+16x-8}{(x+2)(x-2)}$

63. $\frac{5x+6}{2x(x+3)}$

65. **a.** $\frac{100}{x}$ **b.** $\frac{100}{2x+15}$

c. $\frac{100x+1500}{x(2x+15)}$

67. **a.** \$5750

b. $C(x) = 5750+0.35x$

c. $A(x) = \frac{5750+0.35x}{x}$

d. \$6.40 per cupcake

e. \$1.99 per cupcake

12.5 Exercises

Concept Check

1. rational

3. LCM

5. complex algebraic

7. True

9. True

Practice

1. $\frac{4}{5xy}$

3. $\frac{8}{7x^2y}$

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

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

9. $\frac{7}{2(x+2)}$

11. $\frac{x}{x-1}$

13. $\frac{4x}{3(x+6)}$

15. $\frac{7x}{x+2}$

17. $\frac{2x+6}{3(x-2)}$

19. $\frac{24y+9x}{2(9y-10x)}$

21. $\frac{x}{x-1}$

23. $\frac{xy}{x+y}$

25. $\frac{1}{xy}$

27. $\frac{y+x}{y-x}$

29. $\frac{3-x}{x}$

31. $\frac{x+1}{x+3}$

33. $\frac{-1}{x(x+h)}$

35. $\frac{-1}{x(x+h)}$

37. $-(x-2y)(x-y)$

39. $\frac{2x}{x^2+1}$

41. $\frac{(x-3)(x^2-2x+4)}{(x-4)(x-2)(x+1)}$

43. $\frac{-5}{x+1}$

45. $\frac{29}{4(4x+5)}$

47. $\frac{x^2-3x-6}{x(x-1)}$

49. $\frac{x^2-4x-2}{(x-4)(x+4)}$

Applications

51. **a.** $\frac{2r_1r_2}{r_1+r_2}$

b. 44.2 miles per hour

c. 1.8 hours

Writing & Thinking

53. **a.** $\frac{8}{5}$

b. 1

c. $\frac{x^4+x^3+3x^2+2x+1}{x^3+x^2+2x+1}$

12.6 Exercises

Concept Check

1. ratio

3. extraneous

5. variables

7. False; It is not a proportion.

9. True

Practice

1. $x = 7$

3. $x \neq 0, 2$; $x = 4$

5. $x \neq -3, 4$; $x = -10$

7. $x \neq 0$; $x = 18$

9. $x \neq 6$; $x = -\frac{74}{9}$

11. $x = \frac{1}{4}$

13. $x = 6$

15. $x = 4$

17. $x \neq 0$; $x = \frac{10}{3}$

19. $x \neq 0$; $x = -\frac{3}{4}$

21. $x \neq 0$; $x = -\frac{3}{16}$

23. $x \neq -9, -\frac{1}{4}, 0$; $x = -2, 1$

25. $x \neq \frac{3}{2}, 0, 6$; $x = \frac{3}{5}, 9$

27. $x \neq \frac{1}{2}, 4$; $x = -3$

29. $x \neq -4, -1$; $x = 2$

31. $x \neq -1, \frac{1}{4}$; $x = \frac{2}{3}$

33. $x \neq 2, 3$; $x = \frac{13}{10}$

35. $x \neq -\frac{2}{3}, 2$; no solution

37. $x \neq -1, \frac{1}{3}, \frac{1}{2}$; $x = \frac{1}{5}$

39. $r = \frac{S-a}{S}$

41. $s = \frac{x-\bar{x}}{z}$

43. $y = m(x-x_1)+y_1$

45. $R_{\text{total}} = \frac{R_1R_2}{R_1+R_2}$

47. $P = \frac{A}{1+r}$

49. $LK = 15$, $JB = 5$

51. $AC = 2$, $ST = 12$

53. $ST = 8$, $TU = 12$, $QR = 24$

55. $AP = \frac{9}{2}$ in.; $PC = \frac{15}{2}$ in.

Applications

57. 360 defective computers

59. 36,800 students

61. 34 miles

63. 6.8 cups

65. Width = 3 inches; Length = 7.5 inches

67. 4 hours

69. First group: 10 hours; Second group: 6 hours.

71. **a.** $\frac{3x}{3} = \frac{16}{x}$

b. $x = -4, +4$

c. $x = -4$ does not make sense because length cannot be negative

d. The side of the small triangle is 4 feet long and the base of the large triangle is 12 feet long.

Writing & Thinking

73. **a.** $\frac{x^2-8x}{4(x-4)(x+4)}$

b. $x = 0, 8$

75. **a.** $\frac{14x-16}{5x(x-4)}$ **b.** $x = \frac{8}{7}$

12.7 Exercises

Concept Check

1. unit, time

3. check

5. diagram, chart

7. True

Applications

1. 72, 45

3. 9

5. $\frac{6}{13}$

7. 36, 27

9. 7, 12

11. 37.5 miles

13. $\frac{12}{5}$ or $2\frac{2}{5}$ hours

15. $\frac{9}{5}$ or $1\frac{4}{5}$ hours

17. 6 hours

19. Charles: 8 mph; Chase: 6 mph

21. 63 mph

23. Sailboat: 5 mph; Cruise ship: 25 mph

25. 20 mph

27. 120 hours

29. John: 11 hours; Raul: 22 hours; Denny: 33 hours

31. 1 mph

33. **a.** $\frac{1}{x} + \frac{1}{4x} = \frac{1}{4}$

Printer	Time of Work (in Hours)	Part of Work Done in 1 Hour
Newest	x	$\frac{1}{x}$
Old	$4x$	$\frac{1}{4x}$
Together	4	$\frac{1}{4}$

b. $x = 5$

c. It would take the newest printer 5 hours to complete the job and the old printer 20 hours to complete the job.

Writing & Thinking

35. **a.** 5 and 7 **b.** 2 and 4

12.8 Exercises

Concept Check

1. decrease

3. increase

5. joint

7. False; Varies directly

9. True

Practice

1. $\frac{7}{3}$

3. 2

5. $-\frac{32}{9}$

7. 36

9. 120

11. $\frac{56}{3}$

13. 40

15. 54

17. $\frac{48}{5}$

19. 27

Applications

21. 400 feet

23. \$35.10

25. 4.71 feet

27. 6 m

29. 0.0073 cm

31. 16,000 lb

33. 9×10^{-11} N

35. \$59.70

37. **a.** $SL = \frac{kwd}{l^2}$

b. 200 **c.** 4320 pounds

39. 25,200 lb

41. 18,000 lb
43. 200 cm^3
45. 330 bar
47. 5.2 ohms
49. 10 ohms
51. $10\frac{2}{3}$ ft from the 120 lb weight or, $1\frac{1}{3}$ ft from the 960 lb weight.
53. 216 kilograms

Chapter 13: Roots, Radicals, and Complex Numbers

13.1 Exercises

Concept Check

1. 2
3. square root
5. radical, radicand
7. False; If the original number is negative, the principal square root will not be the same as the original number.
9. False; The radicand is underneath the radical symbol.

Practice

1. 3 **3.** 9
5. 17 **7.** 13
9. 1 **11.** 5
13. 6 **15.** $\frac{1}{2}$
17. $\frac{3}{4}$ **19.** 0.2
21. −10 **23.** −0.04
25. −3 **27.** −5
29. $\frac{3}{5}$
31. $\sqrt{64} < \sqrt{74} < \sqrt{81}$ and $8 < \sqrt{74} < 9$ because $64 < 74 < 81$ or $(8.6023)^2 = 73.99956529$
33. $\sqrt{25} < \sqrt{32} < \sqrt{36}$ and $5 < \sqrt{32} < 6$ because $25 < 32 < 36$ or $(5.6569)^2 = 32.00051761$
35. > **37.** <
39. = **41.** =
43. Rational **45.** Rational
47. Irrational
49. Not a real number
51. Rational
53. Irrational
55. 6.2450
57. 2.4960
59. 0.4472
61. 8.9443
63. −8.2462
65. 2.6207
67. 4.9324

Applications

69. $5\sqrt{2}$ or 6.30 inches
71. **a.** 4 inches **b.** 12 tiles
73. 10 inches
75. 4.64 cm
77. **a.** 1.7 meters
b. 1.6 meters
c. 1.8 meters
79. **a.** 4.2 ft **b.** 10.2 ft
c. 18 tiles

Writing & Thinking

81. There is no real number that results in a negative number when squared.

13.2 Exercises

Concept Check

1. factor
3. 2
5. $\sqrt{a}\sqrt{b}$
7. True
9. False; If x is a real number, then $\sqrt{x^2} = |x|$.

Practice

1. $2\sqrt{3}$ **3.** $12\sqrt{2}$
5. $-6\sqrt{2}$ **7.** $-2\sqrt{14}$
9. $-5\sqrt{5}$ **11.** $\frac{1}{2}$
13. $-\frac{\sqrt{11}}{8}$ **15.** $\frac{2\sqrt{7}}{5}$
17. $6x$ **19.** $2x\sqrt{2x}$
21. $2x^5y\sqrt{6x}$
23. $5xy^3\sqrt{5x}$
25. $-3xy\sqrt{2}$
27. $2bc\sqrt{3ac}$
29. $5x^2y^3z^4\sqrt{3}$
31. $\frac{x^2\sqrt{5}}{3}$ **33.** $\frac{4a^2\sqrt{2a}}{9b^8}$
35. $\frac{10x^4\sqrt{2}}{17}$ **37.** 6
39. $2\sqrt[3]{7}$ **41.** −1
43. $-4\sqrt[3]{2}$ **45.** $5x\sqrt[3]{x}$
47. $-2x^2\sqrt[3]{x^2}$
49. $2a^2b\sqrt[3]{9b}$
51. $6x^2y\sqrt[3]{y^2}$
53. $2xy^2z^3\sqrt[3]{3x^2y}$
55. $\frac{\sqrt[3]{3}}{2}$ **57.** $\frac{5\sqrt[3]{3}}{2}$
59. $\frac{5y^4}{3x^2}$

Applications

61. $\sqrt{6} \approx 2.45$ amperes
63. 120 volts
65. **a.** 10 cm
b. $2\sqrt{30}$ cm
c. $5\sqrt{6}$ cm

Writing & Thinking

67. A cube root has no restrictions as the cube root of a negative number is negative.

13.3 Exercises

Concept Check

1. radical, index
3. $a^{\frac{1}{2}}$
5. $\sqrt[3]{a}$
7. True
9. True

Practice

1. $\sqrt[3]{8}$ **3.** $-\sqrt[6]{x}$
5. $\sqrt[5]{4z^2}$ **7.** $13^{\frac{1}{7}}$
9. $(-9)^{\frac{1}{3}}$ **11.** 3
13. $\frac{1}{10}$ **15.** −512
17. −4
19. Not a real number
21. $\frac{3}{7}$ **23.** 16
25. $-\frac{1}{6}$ **27.** $\frac{5}{2}$
29. $\frac{1}{4}$ **31.** $\frac{3}{8}$
33. $-\frac{1}{1000}$ **35.** 64
37. 8.5499 **39.** 10,000,000
41. 99.6055 **43.** 0.0922
45. 1.6083 **47.** 0.2236
49. 7.7460 **51.** 2.0408
53. $8x$ **55.** $\frac{1}{3a^2}$
57. $8x^{\frac{5}{2}}$ **59.** $5a^{\frac{13}{6}}$
61. $x^{\frac{7}{12}}$ **63.** $x^{\frac{1}{2}}$
65. $\frac{1}{a^{\frac{9}{8}}}$ **67.** $a^{\frac{1}{4}}$
69. $\frac{a^2}{b^{\frac{6}{5}}}$ **71.** $8x^{\frac{3}{2}}y$
73. $\frac{x^{\frac{3}{2}}}{16y^{\frac{2}{5}}}$ **75.** $\frac{x^2y^4}{z^4}$

77. $\frac{y^{\frac{3}{2}}z^2}{x}$ **79.** $\frac{8b^{\frac{9}{4}}}{a^3c^3}$

81. $x^{\frac{1}{4}}y^{\frac{5}{4}}$ **83.** $\frac{y^{\frac{2}{3}}}{50x^{\frac{4}{3}}}$

85. $\frac{b^{\frac{5}{12}}}{a^{\frac{11}{12}}}$ **87.** $\frac{3x^{\frac{1}{2}}}{20y^{\frac{2}{3}}}$

89. $\sqrt[6]{x^5}$ **91.** $\sqrt[12]{y^7}$

93. $\sqrt[30]{x^{11}}$ **95.** $\sqrt[6]{y}$

97. $\sqrt[9]{x}$ **99.** $\sqrt[3]{7a}$

101. $\sqrt[24]{x}$ **103.** $a^{20}b^5c^{10}$

Applications

105. 0.24 Earth years

107. 576 ft^2

109. **a.** 20 feet per second

b. 35.78 feet per second

111. **a.** 50 kmph **b.** 20 kmph

Writing & Thinking

113. **a.** n must be an integer greater than 1.

b. n must be a number less than 0.

c. n must equal 0.

d. n must be a rational number that is not an integer.

13.4 Exercises

Concept Check

1. index

3. FOIL

5. True

Practice

1. $8\sqrt{2}$

3. $\sqrt{11}$

5. $-3\sqrt{10}$

7. $13\sqrt[3]{3}$

9. $-\sqrt{11}$

11. $3\sqrt{a}$

13. $7\sqrt{x}$

15. $4\sqrt{2}+3\sqrt{3}$

17. $8\sqrt{b}-4\sqrt{a}$

19. $13\sqrt[3]{x}-2\sqrt[3]{y}$

21. $5\sqrt{3}$

23. 0

25. $17\sqrt[3]{2}$

27. $2\sqrt{2}-6\sqrt{3}$

29. $6+\sqrt{5}$

31. $\sqrt{3}-4\sqrt{2}$

33. $5\sqrt[3]{2}-8\sqrt[3]{3}$

35. $4\sqrt{2x}$

37. $2y\sqrt{2y}$

39. $-4x\sqrt{3xy}$

41. $15x\sqrt{x}$

43. $-xy^2\sqrt{x}$

45. $4x^5y^{10}\sqrt{3}$

47. $-8x^8y^2$

49. $xy^2\sqrt[3]{2}\left(-2x^2y^2-2x^3y+3\right)$

51. $3\sqrt{2}-8$

53. 18

55. $-8\sqrt{3}$

57. $12+\sqrt{6}$

59. $2y+\sqrt{xy}$

61. $13+2\sqrt{2}$

63. $3x-9\sqrt{3x}+8$

65. $2-2\sqrt{7}$

67. $13+4\sqrt{10}$

69. $\sqrt{10}+\sqrt{15}-\sqrt{6}-3$

71. $x-2\sqrt{6x}-18$

73. 58

75. $x+10\sqrt{xy}+25y$

77. $x+28-10\sqrt{x+3}$

79. $2x+19-8\sqrt{2x+3}$

81. 4.3397

83. 31.6

85. −57

87. −37.3569

89. $\sqrt{16}+\sqrt{48}\neq\sqrt{16+48}$, as radicals cannot be added by simply adding their radicands.

Applications

91. $5\sqrt{6}+\sqrt{170}\approx 25.29$ ft

93. **a.** $7\sqrt{2t}$ dollars

b. $\sqrt{2t}$ dollars

95. **a.** $60\sqrt{6}\%$

b. $6x^4\sqrt{2}\%$

13.5 Exercises

Concept Check

1. denominator

3. rational

5. conjugate

7. True

9. False; You would need to multiply by $\sqrt[3]{a^2}$.

Practice

1. $\frac{5\sqrt{2}}{2}$ **3.** $\frac{-3\sqrt{7}}{7}$

5. $2\sqrt{3}$ **7.** 3

9. 3 **11.** $\frac{1}{3}$

13. $\frac{2\sqrt{3}}{3}$ **15.** $\frac{3\sqrt{2}}{2}$

17. $\frac{\sqrt{x}}{x}$ **19.** $\frac{\sqrt{2xy}}{y}$

21. $\frac{\sqrt{2y}}{y}$ **23.** $\frac{3\sqrt{7}}{5}$

25. $\frac{-\sqrt{2y}}{5}$ **27.** $\frac{\sqrt[3]{30}}{3}$

29. $-\frac{5\sqrt{x}}{x^2}$ **31.** $\frac{2\sqrt{3x}}{3y}$

33. $\frac{2\sqrt{b}}{b}$ **35.** $\frac{\sqrt[3]{28xy^2}}{2y^2}$

37. $\frac{x\sqrt[3]{3xy^2}}{3y}$ **39.** $\frac{\sqrt[3]{22}}{2}$

41. $\frac{\sqrt[3]{45ab^2}}{3b^2}$ **43.** $\frac{a\sqrt[3]{2ab^2}}{2b}$

45. $\sqrt{6}+2$ **47.** $\frac{-\left(\sqrt{5}+3\right)}{4}$

49. $\frac{-6\left(5+3\sqrt{2}\right)}{7}$

51. $\frac{\sqrt{3}\left(\sqrt{2}-5\right)}{23}$

53. $\frac{-7\left(1+3\sqrt{5}\right)}{44}$

55. $\frac{-\left(\sqrt{3}+\sqrt{5}\right)}{2}$

57. $5\left(\sqrt{2}-\sqrt{3}\right)$

59. $\frac{4\left(\sqrt{x}-1\right)}{x-1}$

61. $\frac{5\left(6-\sqrt{y}\right)}{36-y}$

63. $\frac{8\left(2\sqrt{x}-3\right)}{4x-9}$

65. $\frac{2\sqrt{y}\left(\sqrt{5y}+\sqrt{3}\right)}{5y-3}$

67. $\frac{3\left(\sqrt{x}+\sqrt{y}\right)}{x-y}$

69. $\frac{x\left(\sqrt{x}-2\sqrt{y}\right)}{x-4y}$

71. $-\left(\sqrt{3}+1\right)\left(\sqrt{3}+2\right)$

73. $\frac{-\left(\sqrt{5}-2\right)\left(\sqrt{5}-3\right)}{4}$

75. $\frac{\left(\sqrt{x}+1\right)^2}{x-1}$

77. $\frac{\left(\sqrt{x}+2\right)\left(\sqrt{3x}-y\right)}{3x-y^2}$

79. The numerator and denominator were not multiplied by the conjugate of the denominator. The conjugate is $\sqrt{3}-y$. Also, the multiplication is incorrect: $\left(\sqrt{3}+y\right)\left(\sqrt{3}+y\right)\neq 3+y^2$.

Applications

81. $r=\frac{\sqrt{V\pi h}}{\pi h}$

83. **a.** $\frac{5\sqrt{6}}{3}$ cm

b. $\frac{2\sqrt{30}}{3}$ cm

c. $\frac{5\sqrt{3}}{3}$ cm

85. **a.** $r=\frac{\sqrt{AP}}{P}-1$

b. 5%

13.6 Exercises

Concept Check

1. isolate **3.** radicals
5. extraneous
7. True **9.** True

Practice

1. $x = 3$ **3.** No solution
5. $x = -3$ **7.** $x = 14$
9. $x = 9$ **11.** No solution
13. $x = 6$ **15.** $x = -4, 1$
17. $x = -5, \frac{5}{2}$
19. $x = -2$ **21.** $x = 2, 3$
23. $x = 2, 5$ **25.** $x = -5, 5$
27. $x = 4$ **29.** $x = 4$
31. $x = 3$ **33.** $x = 2$
35. $x = 2$ **37.** $x = 7$
39. $x = 4$ **41.** $x = 0$
43. $x = 5$ **45.** No solution
47. $x = 4$ **49.** $x = -1, 3$
51. $x = 5$ **53.** $x = 2$
55. $x = 1$ **57.** $x = -4$
59. $x = 12$

Applications

61. **a.** \$1814.06
b. $r = \sqrt{\frac{A}{P}} - 1$
63. **a.** 1 sec **b.** 3 ft
65. 28.63 m
67. **a.** 0.64 seconds
b. 1.01 seconds
c. 1.09 seconds

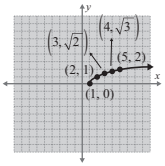
13.7 Exercises

Concept Check

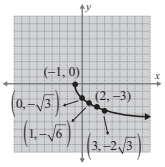
1. ordered
3. first coordinates
5. vertical, function
7. True
9. True

Practice

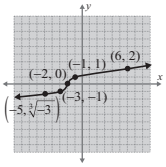
1. **a.** $\sqrt{5} \approx 2.2361$ **b.** 3
c. $5\sqrt{2} \approx 7.0711$ **d.** 2
3. **a.** 3 **b.** -1 **c.** -2
d. $2\sqrt[3]{3} \approx 2.8845$
5. $[-8, \infty)$
7. $\left(-\infty, \frac{1}{2}\right]$
9. $(-\infty, \infty)$
11. $(-\infty, 2]$
13. $(-\infty, \infty)$
15. $D = [-2, \infty); R = [0, \infty)$; zero $= (-2, 0)$
17. $D = [-1, \infty); R = (-\infty, 1]$; zero $= (0, 0)$
19. $D = [0, \infty); R = [3, \infty)$; zero = none
21. E
23. B
25. A
27.



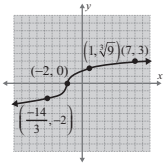
29.



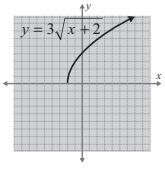
31.



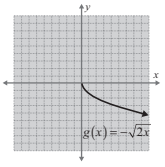
33.



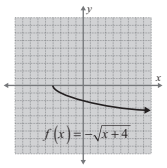
35.



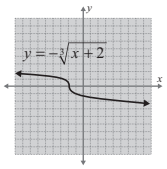
37.



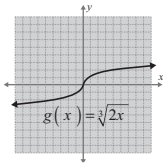
39.



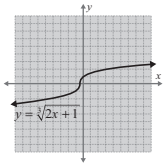
41.



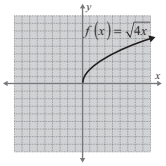
43.



45.

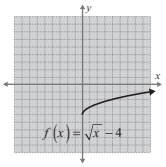


47. **a.**



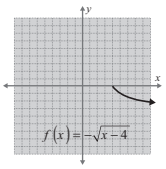
$D = [0, \infty)$; The graph of $\sqrt{x}$ is stretched vertically.

b.



$D = [0, \infty)$; The graph of $\sqrt{x}$ is shifted down four units.

c.

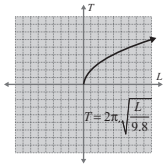


$D = [4, \infty)$; The graph of $\sqrt{x}$ is shifted to the right four units. and then reflected across the x-axis

49. A negative sign reflects the graph across the x-axis.
a. Affects how quickly the graph goes to infinity.
b. Causes the graph to move in a horizontal direction, and
c. Causes the graph to move in a vertical direction.

Applications

51. **a.**



b. $D = [0, \infty); R = [0, \infty)$ Yes, this makes sense since both length and time cannot be negative
c. 7.77 seconds

Writing & Thinking

53. **a.** $\frac{1}{\sqrt{3+h} + \sqrt{3}}$
b. Slope of the line connecting $(3+h, f(3+h))$ and $(3, f(3))$
c. A line just touching the curve at one point
d. $\frac{1}{2\sqrt{3}}$; represents the slope of the line tangent to $f(x)$ at $x = 3$.

13.8 Exercises

Concept Check

1. polynomials
3. real, imaginary
5. $i\sqrt{a}$
7. True
9. False; $a = c$, $b = d$

Practice

1. Real part: 4, imaginary part: -3
3. Real part: -11, imaginary part: $\sqrt{2}$
5. Real part: $\frac{3}{8}$, imaginary part: 0

7. Real part: $\frac{4}{5}$, imaginary part: $\frac{7}{5}$
9. Real part: $\frac{2}{3}$, imaginary part: $\sqrt{17}$
11. $7i$
13. $-8i$
15. $7\sqrt{3}$
17. $10i\sqrt{6}$
19. $-12i\sqrt{3}$
21. $11\sqrt{2}$
23. $10i\sqrt{10}$
25. $x = 6, y = -3$
27. $x = -2, y = \sqrt{5}$
29. $x = \sqrt{2} - 3, y = 1$
31. $x = 1, y = 4$
33. $x = 2, y = -6$
35. $x = 3, y = 10$
37. $x = -\frac{4}{3}, y = -3$
39. $6 + 2i$
41. $1 + 7i$
43. $6 - 6i$
45. $14i$
47. $\left(3 + \sqrt{5}\right) - 6i$
49. $5 + \left(\sqrt{6} + 1\right)i$
51. $\sqrt{3} - 5$
53. $-2 - 5i$
55. $11 - 16i$
57. 2
59. $3 + 4i$

Writing & Thinking

61. **a.** Yes **b.** No

13.9 Exercises

Concept Check

1. FOIL
3. $i, -1, -i, 1$
5. $a^2 + b^2$
7. False; i, $-i$, 1 and -1
9. False; The product is -1.

Practice

1. $16 + 24i$
3. $-7\sqrt{2} + 7i$
5. $3 + 12i$
7. $1 - i\sqrt{3}$
9. $3 + 2i\sqrt{3}$
11. $2 + 8i$
13. $-7 - 11i$
15. $13 + 0i$
17. $34 + 13i$
19. $-24 + 70i$
21. $5 - i\sqrt{3}$
23. $23 - 10i\sqrt{2}$
25. $21 + 0i$
27. $\left(2 + \sqrt{10}\right) + \left(2\sqrt{2} - \sqrt{5}\right)i$
29. $\left(9 - \sqrt{30}\right) + \left(3\sqrt{5} + 3\sqrt{6}\right)i$
31. $0 + 3i$
33. $0 - \frac{5}{4}i$
35. $-\frac{1}{4} + \frac{1}{2}i$
37. $-\frac{4}{5} + \frac{8}{5}i$
39. $\frac{24}{25} + \frac{18}{25}i$
41. $-\frac{1}{13} + \frac{5}{13}i$
43. $-\frac{1}{29} - \frac{12}{29}i$
45. $-\frac{17}{26} - \frac{7}{26}i$
47. $\frac{4 + \sqrt{3}}{4} + \left(\frac{4\sqrt{3} - 1}{4}\right)i$
49. $-\frac{1}{7} + \frac{4\sqrt{3}}{7}i$
51. $0 + i$
53. $-1 + 0i$
55. $0 + i$
57. $1 + 0i$
59. $0 - i$
61. $x^2 + 9$
63. $x^2 + 2$
65. $5y^2 + 4$
67. $x^2 + 4x + 40$
69. $y^2 - 6y + 13$

Writing & Thinking

71. Given a complex number $(a + bi)$: $(a + bi)(a - bi)$
$= a^2 - abi + abi - b^2i^2$
$= a^2 + b^2$
which is the sum of squares of real numbers. Thus, the product must be a positive real number.
73. $a^2 + b^2 = 1$

Chapter 14: Quadratic Equations

14.1 Exercises

Concept Check

1. hypotenuse, squares
3. nonnegative
5. True
7. False; The square of a real number cannot be negative.

Practice

1. $x = 0, 11$
3. $x = -12, -3$
5. $x = 1, -\frac{5}{3}$
7. $x = -1, 3$
9. $x = \frac{3}{4}, 1$
11. $x = \pm 11$
13. $x = \pm 6$
15. $x = \pm\sqrt{35}$
17. $x = \pm 5i$
19. $x = \pm\sqrt{62}$
21. $x = \pm 3\sqrt{5}$
23. $x = \pm 3\sqrt{2}$
25. $x = \pm\frac{2}{3}$
27. $x = -1, 3$
29. $x = -2 \pm 5i$
31. $x = 3 \pm 2i$
33. $x = -\frac{3}{2}, -\frac{1}{2}$
35. $x = \frac{7}{4}, \frac{9}{4}$
37. $x = -2 \pm i\sqrt{7}$
39. $x = \frac{2 \pm 3\sqrt{7}}{5}$
41. $x = \frac{-4 \pm 3\sqrt{3}}{3}$
43. $x = 7 \pm 2\sqrt{3}$
45. $x = 5 \pm i\sqrt{10}$
47. $x = \pm 2i\sqrt{6}$
49. $c = 15$
51. $b = 6\sqrt{3}$
53. $b = 1$
55. $x = \pm 25.44$
57. $x = \pm 5.25$
59. $x = \pm 1.70$
61. $x = \pm 4.13$
63. 4.2361, -0.2361
65. 2.3229, -0.3229

Applications

67. The length of the leg is 4 feet and the hypotenuse is 8 feet.
69. $3\sqrt{2}$ cm
71. **a.** $35^2 = x^2 + 34^2 \rightarrow 8.3$ ft
b. No, $\frac{1}{4}$ of 34 is 8.5, so the distance is too short by 0.2 feet.
73. 125 yards
75. **a.** 640 ft; 384 ft
b. 144 ft; 400 ft
c. 7 seconds; $0 = -16(t + 7)(t - 7)$
77. 3.2 miles

14.2 Exercises

Concept Check

1. trinomial
3. 1
5. square
7. False; It's also possible for there to be one solution.
9. True

Practice

1. $x^2 - 12x + \underline{36} = \left(\underline{x-6}\right)^2$
3. $x^2 + 6x + \underline{9} = \left(\underline{x+3}\right)^2$
5. $x^2 - 5x + \underline{\frac{25}{4}} = \left(\underline{x-\frac{5}{2}}\right)^2$
7. $y^2 + y + \underline{\frac{1}{4}} = \left(\underline{y+\frac{1}{2}}\right)^2$
9. $x^2 + \frac{1}{3}x + \underline{\frac{1}{36}} = \left(\underline{x+\frac{1}{6}}\right)^2$
11. $2x^2 + 4x + 2 = 2\left(x+1\right)^2$
13. $x = -5, 1$
15. $y = -1 \pm \sqrt{6}$
17. $x = 5 \pm \sqrt{22}$
19. $x = -5, 9$
21. $x = -5, 8$
23. $x = -\frac{4}{3}, 1$
25. $x = 3 \pm i$
27. $x = 1, 11$
29. $y = 5 \pm \sqrt{21}$
31. $z = \frac{-3 \pm \sqrt{29}}{2}$
33. $x = \frac{-1 \pm i\sqrt{7}}{2}$ or $-\frac{1}{2} \pm \frac{\sqrt{7}}{2}i$
35. $x = \frac{-5 \pm \sqrt{17}}{2}$
37. $x = \frac{5 \pm \sqrt{10}}{3}$
39. $x = -1 \pm i\sqrt{5}$
41. $x = \frac{1 \pm i\sqrt{11}}{4}$ or $\frac{1}{4} \pm \frac{\sqrt{11}}{4}i$
43. $y = \frac{-3 \pm i\sqrt{11}}{2}$ or $-\frac{3}{2} \pm \frac{\sqrt{11}}{2}i$
45. $y = -\frac{4}{3}, 1$
47. $x = 2 \pm \sqrt{2}$
49. $x^2 - 7 = 0$
51. $x^2 - 2x - 2 = 0$
53. $y^2 + 4y - 16 = 0$
55. $x^2 + 16 = 0$
57. $y^2 + 6 = 0$
59. $x^2 - 4x + 5 = 0$
61. $x^2 - 2x + 3 = 0$
63. $x^2 + 10x + 49 = 0$

Applications

65. **a.** $p = 0$, 90

    b. No income revenue is made if the price is set to \$0 or \$90 per frame.

Writing & Thinking

67. See Example 2.

14.3 Exercises

Concept Check

1. $ax^2 + bx + c = 0$
3. $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
5. completing
7. True
9. False; Two real solutions

Practice

1. 68; Two real solutions
3. 0; One real solution
5. –44; Two nonreal solutions
7. 4; Two real solutions
9. 19,600; Two real solutions
11. –11; Two nonreal solutions
13. $x = -2 \pm 2\sqrt{2}$
15. $x = -\frac{2}{3}$
17. $x = 1 \pm i\sqrt{6}$
19. $x = -3, \frac{1}{2}$
21. $x = \frac{-3 \pm \sqrt{5}}{4}$
23. $x = \frac{-3 \pm i\sqrt{3}}{4}$ or $-\frac{3}{4} \pm \frac{\sqrt{3}}{4}i$
25. $x = \frac{-3 \pm \sqrt{29}}{2}$
27. $x = -3, -1$
29. $x = \pm 2i\sqrt{2}$
31. $x = \frac{5 \pm \sqrt{17}}{2}$
33. $x = -\frac{1}{4}$
35. $x = \pm\frac{2\sqrt{3}}{3}$
37. $x = \frac{2}{3}$
39. $x = \frac{-4 \pm i\sqrt{2}}{2}$ or $-2 \pm \frac{\sqrt{2}}{2}i$
41. $x = \frac{7 \pm i\sqrt{51}}{10}$ or $\frac{7}{10} \pm \frac{\sqrt{51}}{10}i$
43. $x = -2, \frac{5}{3}$
45. $x = 3 \pm i\sqrt{2}$
47. $x = -1, 0$
49. $x = \frac{9 \pm \sqrt{65}}{2}, 0$
51. $x = \frac{-3 \pm \sqrt{5}}{2}, 0$
53. $x = \frac{1}{2}, -3$
55. $x = -\frac{1}{3}, 3$
57. $x = \frac{2 \pm \sqrt{3}}{3}$
59. $x = \frac{1 \pm i\sqrt{3}}{6}$
61. $x = \frac{2 \pm i\sqrt{2}}{2}$
63. $x = \frac{-7 \pm \sqrt{17}}{4}$
65. $c < 16$
67. $c = \frac{81}{4}$
69. $a > 3$
71. $a > -\frac{1}{36}$
73. $a = \frac{49}{48}$
75. $c > \frac{4}{3}$
77. $x \approx 2.5993$, 60.4007
79. $x \approx -0.7862$, 2.0110
81. $x \approx -4.1334$, -0.5806
83. $x \approx -2.6933$, 2.6933

Applications

85. **a.** 3.35 seconds

    b. 4.15 seconds

    c. 0.80 seconds

Writing & Thinking

87. $x^4 - 13x^2 + 36 = 0$; multiplied $\left(x-2\right)\left(x+2\right)\left(x-3\right)\left(x+3\right)$

14.4 Exercises

Concept Check

1. read, think, translate
3. diagram
5. True

Applications

1. $w\left(2w-5\right) = 63$; $w = 7$, the rectangle is 7 m by 9 m
3. $x + \left(x+9\right)^2 = 147$; $x = 3$, the numbers are 3 and 12
5. $\left(w+12\right)\left(w+22\right) = 1344$; $w = 20$, the pool is 20 ft by 30 ft
7. $\left(x+5\right)^2 = 4x^2$; $x = 5$, the side of the original square is 5 m
9. $w^2 + \left(w+4\right)^2 = 400$; $w = 12$, the rectangle is 12 m by 16 m
11. $x\left(x+16\right) = 960$; $x = 24$, there are 40 seats

13. **a.** $x(29-x)=198$

b. $x=11$ or $x=18$

c. Either
length = 11 meters and width = 18 meters, or
length = 18 meters and width = 11 meters.

15. $(9+2x)(12+2x)$
$-(9)(12)=162;$
$x=3$, the frame is 3 in. thick

17. $40I-4I^2=100;\ I=5$, It needs a current of 5 amperes

19. $x(40-x)=336;\ x=12$, 28; He must sell 12 signs

21. **a.** \$307.20

b. $(600+20x)(0.5-0.01x)$
$=315;$
$x=5$, 15; He must charge 45 cents or 35 cents

23. $(15-x)(700+70x)$
$=10{,}920;$
$x=2$ or 3, the rental rate is \$840 or \$910.

25. $\frac{8}{x+2}+\frac{4}{x-2}=2;$
$x=6$, the speed of the boat in still water is 6 mph

27. $\frac{540}{x-9}-\frac{540}{x}=2;$ their average speed to San Francisco was 54 mph

29. $\frac{120}{x}+2=\frac{120}{x-5};\ x=20,$ there were initially 20 members

31. $3w(w+6)=336;\ w=8,$ the sheet metal was 14 in. by 20 in.

33. $\frac{1}{x}+\frac{1}{x+8}=\frac{1}{3};\ x=4$, the mother would take 4 hours

35. $\frac{1}{x}+\frac{1}{x+30}=\frac{1}{8};\ x=10;$ the smaller pipe would take 40 min

37. **a.** $\frac{1}{x}+\frac{1}{x+6}=\frac{1}{4}$

Persons	Time of work (in Hours)	Part of work Done in 1 Hour
Jack	x	$\frac{1}{x}$
Diane	$x+6$	$\frac{1}{x+6}$
Together	4	$\frac{1}{4}$

b. $x=-4,\ 6$

c. 6 hours; Time cannot be negative in this context.

d. It would take Jack 6 hours to decorate the nursery and it would take Diane 12 hours to decorate the nursery.

39. **a.** 4 sec

b. No, the projectile's maximum height is 256 ft.

c. 3 seconds, 5 seconds

d. 8 sec

41. 34.6 ft

Writing & Thinking

43. a cannot be equal to zero and b^2 must be greater than or equal to $4ac$ to produce a real solution. Also, all the solutions found may not apply to the problem at hand. You must check that each answer makes sense in the context of the problem.

14.5 Exercises

Concept Check

1. middle, one-half

3. first

5. True

7. True

Practice

1. $x=\pm 2,\pm 3$

3. $x=\pm 2,\pm\sqrt{5}$

5. $y=\pm\sqrt{7},\pm 2i$

7. $y=\pm\sqrt{5},\pm i\sqrt{5}$

9. $x=4,\frac{25}{4}$

11. $x=1,4$

13. $x=-8,\frac{1}{8}$

15. $x=-27,-8,0$

17. $x=-17,-2$

19. $x=-\frac{7}{2},-3$

21. $x=0,8$

23. $x=-1,-\frac{1}{2}$

25. $x=\pm\sqrt{1+i},\pm\sqrt{1-i}$

27. $x=\pm\sqrt{1+3i},\pm\sqrt{1-3i}$

29. $x=\pm\sqrt{2+i\sqrt{3}},$
$\pm\sqrt{2-i\sqrt{3}}$

31. $x=\frac{1}{7},\frac{1}{5}$

33. $x=-\frac{1}{3},\frac{3}{8}$

35. $x=\frac{1}{25}$

37. $x=\pm\frac{\sqrt{5}}{5},\pm 1$

39. $x=\pm\frac{\sqrt{6}}{2},\pm\frac{1}{3}i$

41. $x=-\frac{1}{4}$

43. $x=-4,1$

45. $x=-\frac{1}{2}$

47. $x=-7,-\frac{3}{2}$

49. $x=\frac{26}{5}$

51. $x=0,\pm 2\sqrt{2},\pm 2i\sqrt{2}$

53. $x=2,-1\pm i\sqrt{3}$

55. $x=-10,0,5\pm 5i\sqrt{3}$

Writing & Thinking

57. **a.** $l^2-l-1=0,$
$l=\frac{1+\sqrt{5}}{2}$ which is the golden ratio

b. 97.08 feet

c. Rectangle B is "golden."

14.6 Exercises

Concept Check

1. parabola

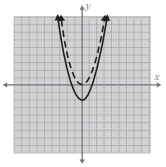
3. ≥

5. range

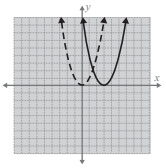
7. False; It is a horizontal shift (or horizontal translation).

Practice

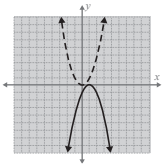
1. **a.**



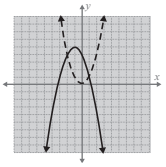
b.



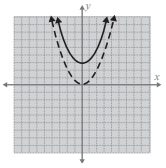
c.



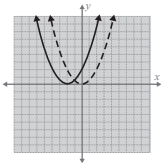
d.



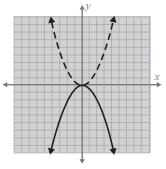
3. **a.**



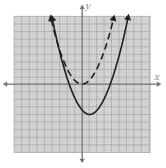
b.



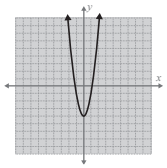
c.



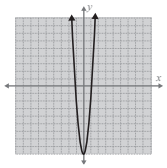
d.



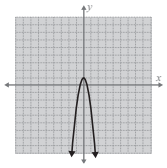
5. $x = 0; (0, -4)$



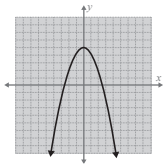
7. $x = 0; (0, -9)$



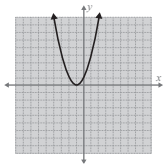
9. $x = 0; (0, 1)$



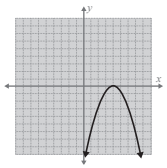
11. $x = 0; (0, 5)$



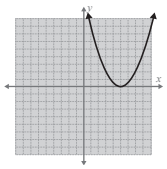
13. $x = -1; (-1, 0)$



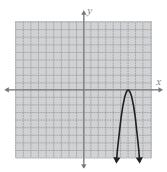
15. $x = 4; (4, 0)$



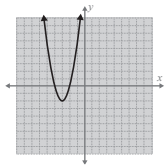
17. $x = 5; (5, 0)$



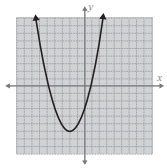
19. $x = 6; (6, 0)$



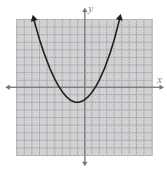
21. $x = -3; (-3, -2)$



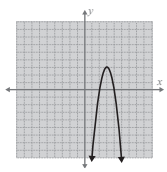
23. $x = -2; (-2, -6)$



25. $x = -1; (-1, -2)$



27. $x = 3; (3, 3)$



Writing & Thinking

29. The parabola is narrower for larger values of a because the value of y increases faster for increasing values of x.

14.7 Exercises

Concept Check

1. vertex

3. x-axis

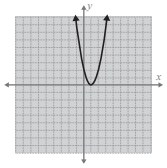
5. downward, highest, maximum

7. False; The line of symmetry is at $x = -\frac{b}{2a}$.

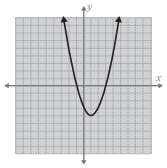
9. True

Practice

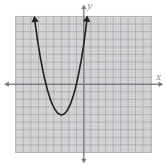
1. $y = 2(x-1)^2$; $x = 1$;
Vertex: $(1, 0)$; x-int: $(1, 0)$;
y-int: $(0, 2)$



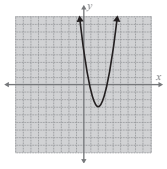
3. $y = (x-1)^2 - 4$; $x = 1$;
Vertex: $(1, -4)$;
x-int: $(-1, 0), (3, 0)$;
y-int: $(0, -3)$



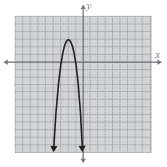
5. $y = (x+3)^2 - 4$; $x = -3$;
Vertex: $(-3, -4)$;
x-int: $(-5, 0), (-1, 0)$;
y-int: $(0, 5)$



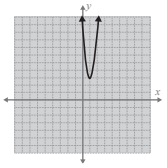
7. $y = 2(x-2)^2 - 3$; $x = 2$;
Vertex: $(2, -3)$;
x-int: $\left(\frac{4+\sqrt{6}}{2}, 0\right)$, $\left(\frac{4-\sqrt{6}}{2}, 0\right)$;
y-int: $(0, 5)$



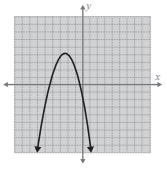
9. $y = -3(x+2)^2 + 3$;
$x = -2$; Vertex: $(-2, 3)$;
x-int: $(-1, 0), (-3, 0)$;
y-int: $(0, -9)$



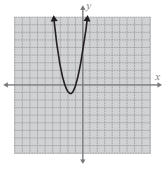
11. $y = 5(x-1)^2 + 3$;
$x = 1$; Vertex: $(1, 3)$;
x-int: None; y-int: $(0, 8)$



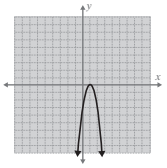
13. $y = -\left(x + \frac{5}{2}\right)^2 + \frac{17}{4}$;
$x = -\frac{5}{2}$;
Vertex: $\left(-\frac{5}{2}, \frac{17}{4}\right)$;
x-int: $\left(\frac{-5+\sqrt{17}}{2}, 0\right)$, $\left(\frac{-5-\sqrt{17}}{2}, 0\right)$;
y-int: $(0, -2)$



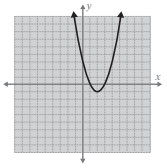
15. $y = 2\left(x + \frac{7}{4}\right)^2 - \frac{9}{8}$;
$x = -\frac{7}{4}$;
Vertex: $\left(-\frac{7}{4}, -\frac{9}{8}\right)$;
x-int: $\left(-\frac{5}{2}, 0\right), (-1, 0)$;
y-int: $(0, 5)$



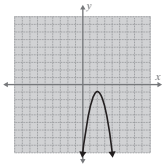
17. $x = 1$; Vertex: $(1, 0)$; x-int: $(1, 0)$; y-int: $(0, -3)$



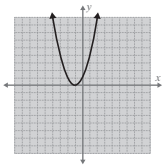
19. $x = 2$; Vertex: $(2, -1)$; x-int: $(3, 0), (1, 0)$; y-int: $(0, 3)$



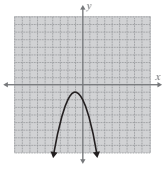
21. $x = 2$; Vertex: $(2, -1)$; x-int: None; y-int: $(0, -9)$



23. $x = -1$; Vertex: $(-1, 0)$; x-int: $(-1, 0)$; y-int: $(0, 1)$

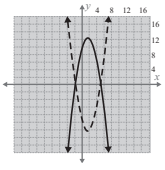


25. $x = -1$; Vertex: $(-1, -1)$; x-int: None; y-int: $(0, -2)$



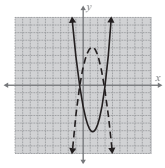
27. **a.** No **b.** Yes

c. One function is a reflection of the other across the x-axis.



29. **a.** No **b.** Yes

c. One function is a reflection of the other across the x-axis.

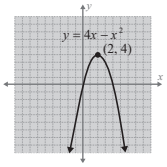


31. Zeros: $x \approx -0.7321$, 2.7321

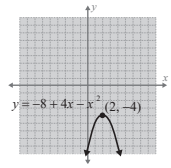
33. Zeros: $x \approx -1.1583$, 2.1583

35. No real zeros

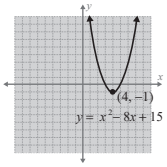
37.



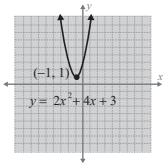
39.



41.



43.



Applications

45. **a.** 3.5 s **b.** 196 ft

47. **a.** 5 s **b.** 420 ft

49. **a.** \$50 **b.** \$2500

51. \$20

53. **a.** Two sides are 150 yards and one side is 300 yards;

b. 45,000 yd^2

Writing & Thinking

55. **a.** Parabola **b.** $x = -\dfrac{b}{2a}$

c. $x = -\dfrac{b}{2a}$

d. No. A graph can be entirely above or below the x-axis.

14.8 Exercises

Concept Check

1. graphs

3. endpoints

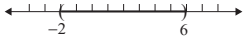
5. bracket, parenthesis

7. False; The goal is to get 0 on one side of the inequality and factor the other side.

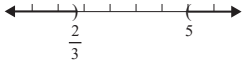
9. False; The solution consists of all intervals where the test points satisfy the original inequality.

Practice

1. $(-2, 6)$

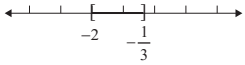


3. $\left(-\infty, \dfrac{2}{3}\right) \cup (5, \infty)$

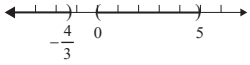


5. $(-\infty, -7] \cup \left[\dfrac{5}{2}, \infty\right)$

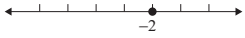
7. $\left[-2, -\dfrac{1}{3}\right]$



9. $\left(-\infty, -\dfrac{4}{3}\right) \cup (0, 5)$

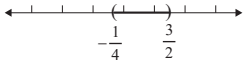


11. $\{-2\}$

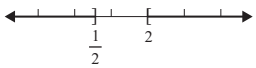


13. $\left(-\infty, -\dfrac{5}{2}\right) \cup (3, \infty)$

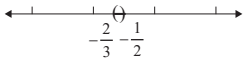
15. $\left(-\dfrac{1}{4}, \dfrac{3}{2}\right)$



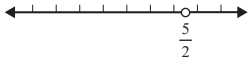
17. $\left(-\infty, \dfrac{1}{2}\right] \cup [2, \infty)$



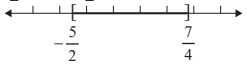
19. $\left(-\dfrac{2}{3}, -\dfrac{1}{2}\right)$



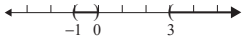
21. $\left(-\infty, \dfrac{5}{2}\right) \cup \left(\dfrac{5}{2}, \infty\right)$



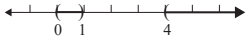
23. $\left[-\dfrac{5}{2}, \dfrac{7}{4}\right]$



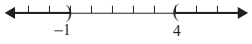
25. $(-1, 0) \cup (3, \infty)$



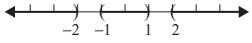
27. $(0, 1) \cup (4, \infty)$



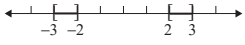
29. $(-\infty, -1) \cup (4, \infty)$



31. $(-\infty, -2) \cup (-1, 1) \cup (2, \infty)$

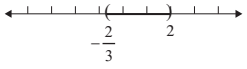


33. $[-3, -2] \cup [2, 3]$



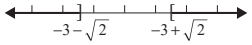
35. $(-\infty, -4] \cup [2, \infty)$

37. $\left(-\dfrac{2}{3}, 2\right)$

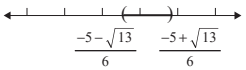


39. $\left(-\infty, -1 - \sqrt{5}\right) \cup \left(-1 + \sqrt{5}, \infty\right)$

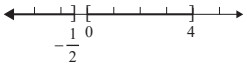
41. $\left(-\infty, -3 - \sqrt{2}\right] \cup \left[-3 + \sqrt{2}, \infty\right)$



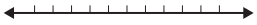
43. $\left(\frac{-5-\sqrt{13}}{6}, \frac{-5+\sqrt{13}}{6}\right)$



45. $\left(-\infty, -\frac{1}{2}\right] \cup [0, 4]$



47. $(-\infty, \infty)$



49. $\varnull$

51. **a.** $x = \frac{7 \pm \sqrt{89}}{2}$

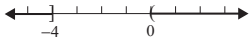
b. $\left(-\infty, \frac{7-\sqrt{89}}{2}\right) \cup \left(\frac{7+\sqrt{89}}{2}, \infty\right)$

c. $\left(\frac{7-\sqrt{89}}{2}, \frac{7+\sqrt{89}}{2}\right)$

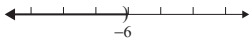
53. **a.** $x = -5, 1$ **b.** $(-5, 1)$

c. $(-\infty, -5) \cup (1, \infty)$

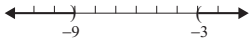
55. $(-\infty, -4] \cup [0, \infty)$



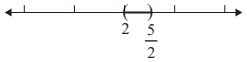
57. $(-\infty, -6)$



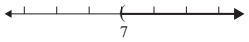
59. $(-\infty, -9) \cup (-3, \infty)$



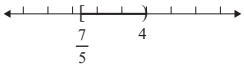
61. $\left(2, \frac{5}{2}\right)$



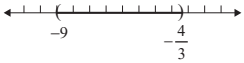
63. $(7, \infty)$



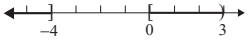
65. $\left[\frac{7}{5}, 4\right)$



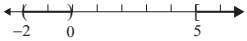
67. $\left(-9, -\frac{4}{3}\right)$



69. $(-\infty, -4] \cup [0, 3)$



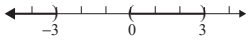
71. $(-2, 0) \cup [5, \infty)$



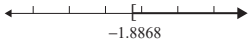
73. $(-\infty, -3.1623) \cup (3.1623, \infty)$

75. $\varnull$

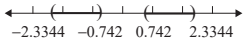
77. $(-\infty, -3) \cup (0, 3)$



79. $[-1.8868, \infty)$



81. $(-2.3344, -0.7420) \cup (0.7420, 2.3344)$



Applications

83. $[3, 9]$

Writing & Thinking

85. **a.** $(-4, 0) \cup (1, \infty)$

b. $(-\infty, -4) \cup (0, 1)$

c. The function is undefined at $x = 0$.

Chapter 15: Exponential and Logarithmic Functions

15.1 Exercises

Concept Check

1. composition, inverses

3. domain

5. y-values, x

7. True

9. False; The operations are restricted to the portions of the domain that are in common.

Practice

1. **a.** $2x - 3$ **b.** 7

c. $x^2 - 3x - 10$

d. $\frac{x+2}{x-5}, x \neq 5$

3. **a.** $x^2 + 3x - 4$

b. $x^2 - 3x + 4$

c. $3x^3 - 4x^2$

d. $\frac{x^2}{3x-4}, x \neq \frac{4}{3}$

5. **a.** $x^2 + x - 12$

b. $x^2 - x - 6$

c. $x^3 - 3x^2 - 9x + 27$

d. $x + 3, x \neq 3$

7. **a.** $3x^2 + x + 2$

b. $x^2 + x - 2$

c. $2x^4 + x^3 + 4x^2 + 2x$

d. $\frac{2x^2 + x}{x^2 + 2}$

9. **a.** $2x^2 + 2$ **b.** $8x$

c. $x^4 - 14x^2 + 1$

d. $\frac{x^2 + 4x + 1}{x^2 - 4x + 1}, x \neq 2 \pm \sqrt{3}$

11. 9

13. $-a^2 - a - 1$

15. 27

17. $\frac{8}{5}$

19. -31

21. $\sqrt{2x-6} + x + 4$, $D = [3, \infty)$

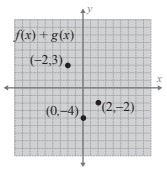
23. $3x^2 - 19x - 14$; $D = (-\infty, \infty)$

25. $\frac{x-5}{\sqrt{x+3}}; D = (-3, \infty)$

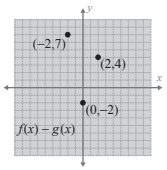
27. $-3x\sqrt{x-3}; D = [3, \infty)$

29. $\sqrt[3]{x+3} + \sqrt{5+x}$; $D = [-5, \infty)$

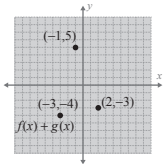
31. **a.**



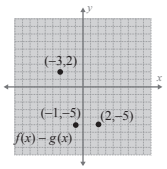
b.



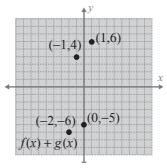
33. **a.**



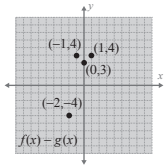
b.



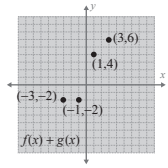
35. **a.**



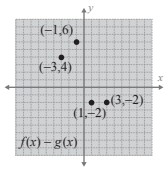
b.



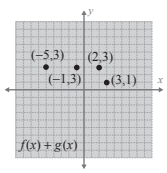
37. **a.**



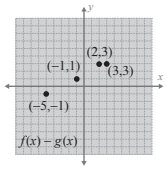
b.



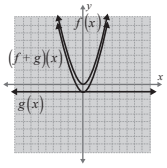
39. **a.**



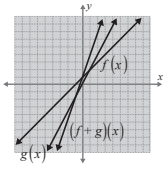
b.



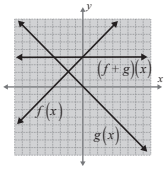
41.



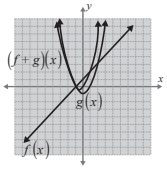
43.



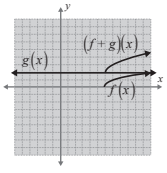
45.



47.



49.

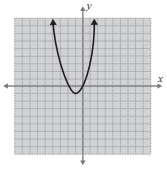


51. 4

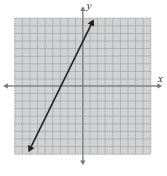
53. −12

55. $-\frac{3}{7}$

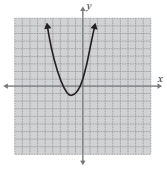
57.



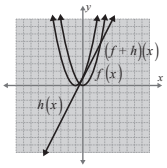
59.



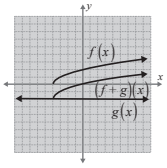
61.



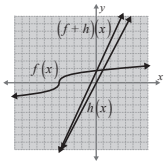
63.



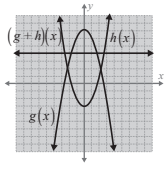
65.



67.



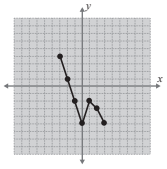
69.



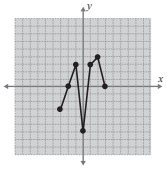
Writing & Thinking

71. In general, subtraction is not commutative. Answers will vary.

73. a.



b.



c. $\frac{f}{g}$ is undefined for $x = -2$ as $g(-2) = 0$.

15.2 Exercises

Concept Check

1. variable, variable

3. ≠

5. one-to-one

7. False; The vertical line test determines whether a graph represents a function.

9. True

Practice

1. a. $8r - 5$ **b.** $24a - 13$

3. a. $5x^2 - 20x + 24$

b. $45n^4 + 4$

5. a. $3n^2 - 6n - 9$

b. $48y^6 + 24y^3 - 9$

7. $f(g(2)) = 14$

$g(f(2)) = \frac{15}{2}$

9. $(f \circ g)(-5) = 49$

$(g \circ f)(-1) = 5$

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

$g(f(x)) = (\sqrt{x})^2 = x$

13. $f(g(x)) = \sqrt{x-2}$

$g(f(x)) = \sqrt{x} - 2$

15. $f(g(x)) = \frac{1}{x^2} - 1$

$g(f(x)) = \frac{1}{(x-1)^2}$

17. $f(g(x)) = x^3 + 3x^2 + 4x + 3$

$g(f(x)) = x^3 + x + 2$

19. $f(g(x)) = \frac{1}{|x|}$

$g(f(x)) = \frac{1}{x}$

21.

$f(g(x)) = \frac{1}{x^2 + 7x - 8}$

$g(f(x)) = \left(\frac{1}{x}\right)^2 + 7\left(\frac{1}{x}\right) - 8$

23. $f(g(x)) = (2x-6)^{3n}$

$g(f(x)) = 2x^{3n} - 6$

25. $f(g(x)) = (x-8)^{\frac{3}{2}}$

$g(f(x)) = \sqrt{x^3 - 8}$

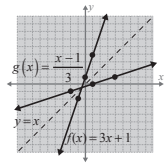
27. a. 21 **b.** 2

c. No; $f(g(x)) \neq x$ and $g(f(x)) \neq x$

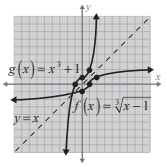
29. a. –9 **b.** does not exist

c. $f(4) = \frac{1}{9}$ and $\frac{1}{9}$ is in the domain of g, so $g(f(4))$ is defined. However, $g(2) = -\frac{1}{2}$ and $-\frac{1}{2}$ is not in the domain of f, so $f(g(2))$ is not defined.

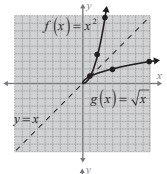
31.



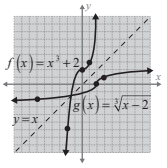
33.



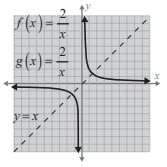
35.



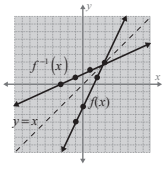
37.



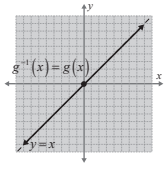
39.



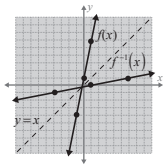
41. $f^{-1}(x) = \frac{x+3}{2}$



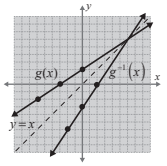
43. $g^{-1}(x) = x$



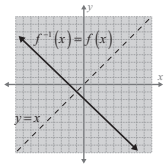
45. $f^{-1}(x)=\dfrac{x-1}{5}$



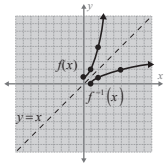
47. $g^{-1}(x)=\dfrac{3(x-2)}{2}$



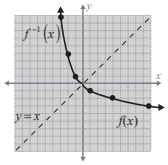
49. $f^{-1}(x)=-x-2$



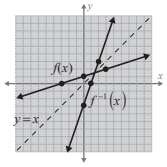
51. $f^{-1}(x)=\sqrt{x-1}$



53. $f^{-1}(x)=x^2,\ x\le 0$



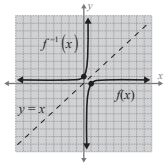
55. One-to-one



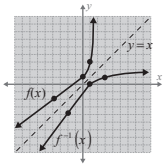
57. Not one-to-one

59. Not one-to-one

61. One-to-one



63. One-to-one



65. One-to-one

67. Not one-to-one

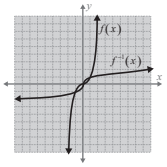
69. One-to-one

71. One-to-one

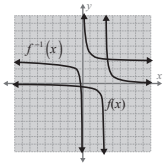
73. One-to-one

75. Not one-to-one

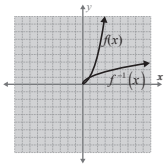
77. $f^{-1}(x)=\sqrt[3]{x}$



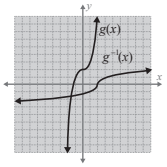
79. $f^{-1}(x)=\dfrac{1}{x}+3$



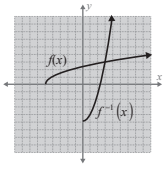
81. $f^{-1}(x)=\sqrt{x}$



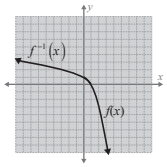
83. $g^{-1}(x)=\sqrt[3]{x-2}$



85. $f^{-1}(x)=x^2-5,\ x\ge 0$



87. $f^{-1}(x)=\sqrt{1-x}$



Writing & Thinking

89. The domain of $f(g(x))$ can only include values of x in the domain of g, while $g(f(x))$ can only include values of x in the domain of f. For example, $f(x)=\sqrt{x}, g(x)=-x$. Answers will vary.

15.3 Exercises

Concept Check

1. constant, variable

3. 0, 1

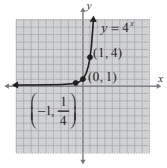
5. compound

7. False; $b > 0$ and $b \neq 1$

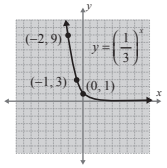
9. True

Practice

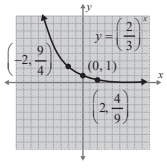
1.



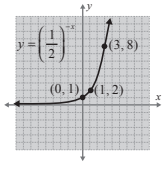
3.



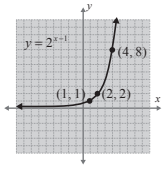
5.



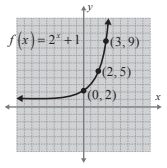
7.



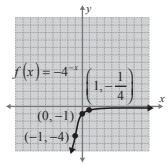
9.



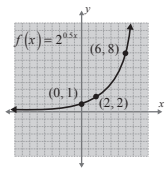
11.



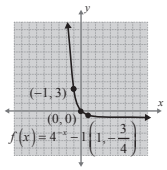
13.



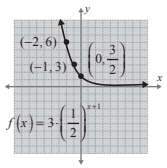
15.



17.



19.

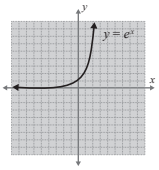


21. 48

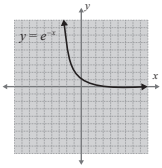
23. 12.27

25. 4108.87

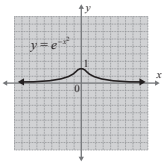
27. **a.**



b.



c.



Applications

29. 20,000 bacteria

31. **a.** \$2621.59

b. \$2633.62

c. \$2639.86

d. \$2646.19

e. \$2646.26

33. \$3210.06

35. \$53.33

37. **a.** \$100,149.34

b. \$222,886.46

c. \$1,103,963.86

39. **a.** \$63,890.56

b. \$17,182.82

c. Answers will vary.

41. \$1228.25

43. $y = 10{,}000 \cdot 2^t$

Writing & Thinking

45. The graphs are reflections of each other across the x-axis.

15.4 Exercises

Concept Check

1. $\log_b x$

3. logarithmic

5. reflecting

7. True

9. True

Practice

1. $\log_7 49 = 2$

3. $\log_5 \frac{1}{25} = -2$

5. $\log_\pi 1 = 0$

7. $\log_{10} 100 = 2$

9. $\log_{10} 23 = k$

11. $\log_{\frac{2}{3}} \frac{4}{9} = 2$

13. $3^2 = 9$

15. $9^{\frac{1}{2}} = 3$

17. $7^{-1} = \frac{1}{7}$

19. $10^{1.74} = N$

21. $b^4 = 18$

23. $n^x = y^2$

25. 4 **27.** 0

29. –3 **31.** $x = 16$

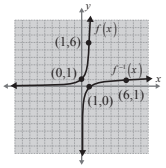
33. $x = 2$ **35.** $x = -3$

37. $x = \frac{1}{6}$ **39.** $x = 2$

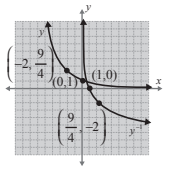
41. $x = 32$ **43.** $x = 3.7$

45. $x = 2$

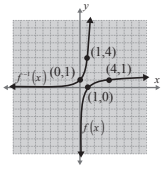
47.



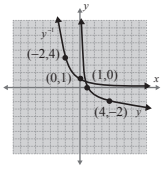
49.



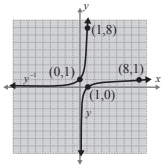
51.



53.



55.



57. **a.** $D = (-\infty, \infty)$

b. $R = (0, \infty)$ **c.** $y = 0$

d. Answers will vary.

Writing & Thinking

59. The two functions are symmetric about the line $y = x$.

15.5 Exercises

Concept Check

1. exponents, exponents

3. difference between

5. sum, difference

7. True

9. True

Practice

1. **a.** 2 **b.** 3 **c.** 5 **d.** 6

3. 5 **5.** –2

7. $\frac{1}{2}$ **9.** 10

11. $\sqrt{3}$

13. $\log_b 5 + 4\log_b x$

15. $\log_b 2 - 3\log_b x + \log_b y$

17. $\log_6 2 + \log_6 x - 3\log_6 y$

19. $2\log_b x - \log_b y - \log_b z$

21. $-2\log_5 x - 2\log_5 y$

23. $\frac{1}{3}\log_6 x + \frac{2}{3}\log_6 y$

25. $\frac{1}{2}\log_3 x + \frac{1}{2}\log_3 y - \frac{1}{2}\log_3 z$

27. $\log_5 21 + 2\log_5 x + \frac{2}{3}\log_5 y$

29. $-\frac{1}{2}\log_6 x - \frac{5}{2}\log_6 y$

31. $-9\log_b x - 6\log_b y + 3\log_b z$

33. $\log_b\left(\frac{9x}{5}\right)$

35. $\log_2 63x^2$

37. $\log_b x^2 y$

39. $\log_5\left(\frac{y^3}{\sqrt{x}}\right)$ or $\log_5\left(\frac{y^3\sqrt{x}}{x}\right)$

41. $\log_5\sqrt{\frac{x}{y}}$

43. $\log_2\left(\frac{xz}{y}\right)$

45. $\log_b\left(\frac{xy^2}{\sqrt{z}}\right)$ or $\log_b\left(\frac{xy^2\sqrt{z}}{z}\right)$

47. $\log_5\left(2x^3 + x^2\right)$

49. $\log_2\left(x^2 + 2x - 3\right)$

51. $\log_b(x+1)$

53. $\log_{10}\left(\frac{1}{2x-3}\right)$

Writing & Thinking

55. Answers will vary.

15.6 Exercises

Concept Check

1. 10

3. negative

5. $\ln x$

7. False; When the base is omitted, it is understood to be 10.

9. False; Both common logarithms and natural logarithms have inverses.

Practice

1. $\log x = 1.5$

3. $\log\frac{1}{1000} = -3$

5. $\ln 27 = x$

7. $\ln 1 = 0$

9. $\log 3.2 = x$

11. $10^0 = 1$

13. $10^y = 5.4$

15. $e^{1.54} = x$

17. $e^1 = e$

19. $e^a = x$

21. 2.2380

23. 1.9465

25. –1.2418

27. 3.6243

29. Error (undefined)

31. –5.3795 **33.** 204.1738

35. 0.0120 **37.** 0.9572

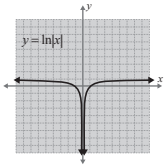
39. 175.9148 **41.** 0.0002

43. 1.0403

Writing & Thinking

45. $\log x$ is a base 10 logarithm. $\ln x$ is a base e logarithm.

47. $D = (-\infty, 0) \cup (0, \infty)$



15.7 Exercises

Concept Check

1. logarithm
3. 1
5. $\frac{1}{b^x}$
7. False; The change of base formula is $\log_b x = \frac{\log_a x}{\log_a b}$.
9. True

Practice

1. $x = 11$
3. $x = 9$
5. $x = \frac{7}{2}$
7. $x = \frac{6}{5}$
9. $x = \frac{7}{2}$
11. $x = -5$
13. $x = -3$
15. $x = -1, 4$
17. $x = -1, \frac{3}{2}$
19. $x = -2, 3$
21. $x = -2$
23. $x = -\frac{3}{2}, 0$
25. $x = -1, 3$
27. $x \approx 0.7154$
29. $x \approx 7.5098$
31. $x \approx -1.5947$
33. $x \approx 0.2473$
35. $x \approx -7.7003$
37. $t \approx -1.5193$
39. $x \approx 3.3219$
41. $x \approx -1.4307$
43. $x = 1$
45. $x \approx -4.1610$
47. $x \approx 1.2058$
49. $x \approx 1.1292$
51. $x \approx 0.9513$
53. $x \approx 1.2520$
55. $x \approx 25.1189$
57. $x \approx 31.6228$
59. $x = 0.0001$
61. $x \approx 4.9530$
63. $x \approx \pm 0.3329$
65. $x = 3$
67. $x = 100$
69. $x = 6$
71. $x = 20$
73. $x \approx 3.1893$
75. No solution
77. No solution
79. $x = 105$
81. $x \approx 22.0855$
83. $x = -10, 8$
85. 2.2619
87. 0.3223
89. −0.6279
91. 2.4391
93. −1.2222
95. $x \approx 2.3219$
97. $x \approx 1.5480$
99. $x \approx 0.8390$

Writing & Thinking

101. Answers will vary.

$$x = \frac{1}{2}$$

103. $7 \cdot 7^x = 7^{1+x}$ and $49^x = 7^{2x}$. Since $1 + x \neq 2x$, in general, $7 \cdot 7^x \neq 49^x$. Answers will vary.

15.8 Exercises

Concept Check

1. decomposition, centuries
3. Richter
5. False; The variable t is measured in days.

Applications

1. $4027.51
3. 11.55 years
5. $f \approx 0.30$
7. 1.73 hours
9. 10.99 days
11. 7.44 hours
13. 2350.02 years
15. 2.31 days
17. 39.65 minutes
19. 7.00 years
21. 5600 years
23. **a.** 13.86 years
    b. 6.93 years
25. 100
27. 8.64 million
29. 2083, 2437, 2744
31. **a.** 117.95 dB
    b. $3.16 \times 10^8 I_0$
    c. $10^6 I_0$

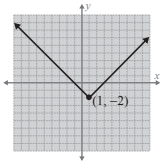
Chapter 16: Conic Sections

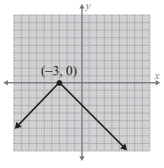
16.1 Exercises

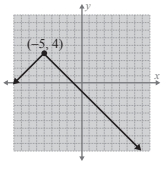
Concept Check

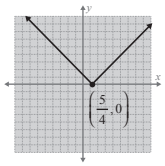
1. slope, two
3. horizontal
5. shape, direction
7. False; Translation does not change the shape of the graph of a function.

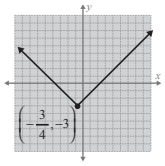
Practice

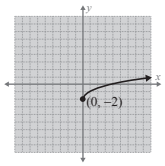
1. **a.** 0 **b.** $a^2 - 6a + 5$
   c. $x^2 + 2xh + h^2 - 4$
   d. $2x + h$
3. **a.** 0 **b.** $2a^2 - 11a + 14$
   c. $2x^2 + 4xh - 3x + 2h^2 - 3h$
   d. $4x + 2h - 3$
5. 1
7. −2
9. The results are the coefficients of x.
11. 

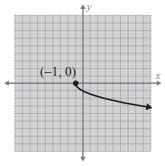
13. 

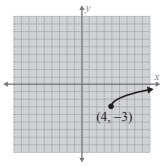
15. 

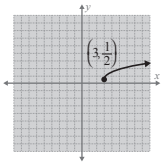
17. 

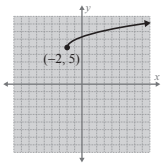
19. 

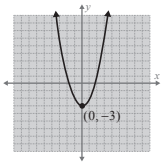
21. 

23. 

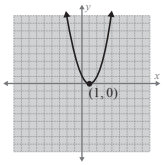
25. 

27. 

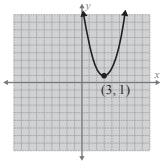
29. 

31. 

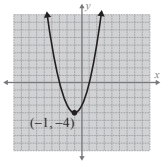
33.



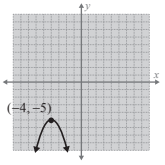
35.



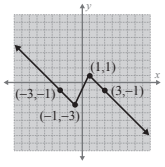
37.



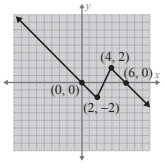
39.



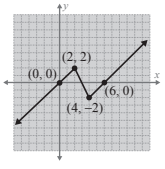
41.



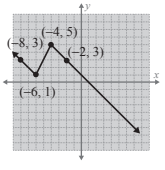
43.



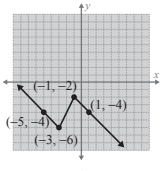
45.



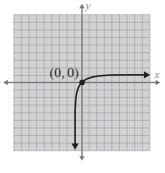
47.



49.

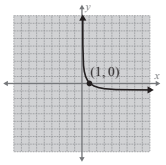


51.



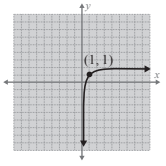
$D = (-1, \infty); R = (-\infty, \infty)$

53.



$D = (0, \infty); R = (-\infty, \infty)$

55.



$D = (0, \infty); R = (-\infty, \infty)$

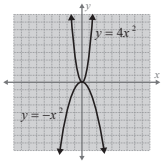
Applications

57. $y = x^4 - 5x^2 + 2x + 10$

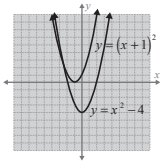
Writing & Thinking

59. The graph of the function $y = f(x - h) + k$ is the graph of the function $y = f(x)$ shifted h units to the right and k units up.

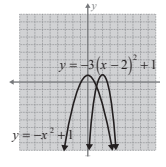
61.



63.



65.



16.2 Exercises

Concept Check

1. circle, ellipse, parabola, hyperbola

3. vertical

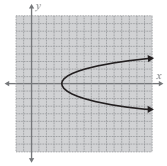
5. 0, y-intercepts

7. True

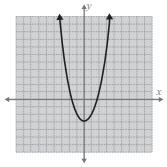
9. False; $y = k$ is the line of symmetry for a horizontal parabola.

Practice

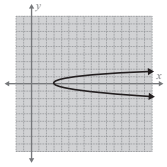
1. **a.** $(4, 0)$ **b.** None
c. $y = 0$



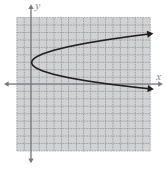
3. **a.** $(0, -3)$ **b.** $(0, -3)$
c. $x = 0$



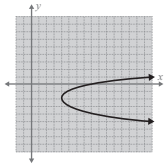
5. **a.** $(3, 0)$ **b.** None
c. $y = 0$



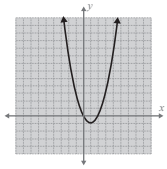
7. **a.** $(0, 3)$ **b.** $(0, 3)$
c. $y = 3$



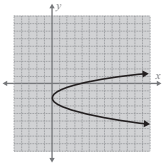
9. **a.** $(4, -2)$ **b.** None
c. $y = -2$



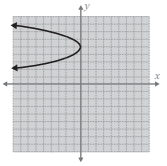
11. **a.** $(1, -1)$ **b.** $(0, 0)$
c. $x = 1$



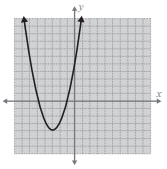
13. **a.** $(0, -2)$ **b.** $(0, -2)$
c. $y = -2$



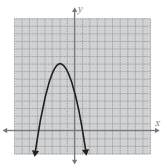
15. **a.** $(0, 5)$ **b.** $(0, 5)$
c. $y = 5$



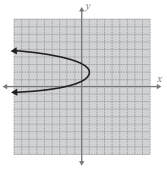
17. **a.** $(-3, -4)$ **b.** $(0, 5)$
c. $x = -3$



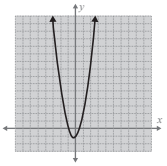
19. **a.** $(-2, 9)$ **b.** $(0, 5)$
c. $x = -2$



21. **a.** $(1, 2)$ **b.** $(0, 1), (0, 3)$
c. $y = 2$



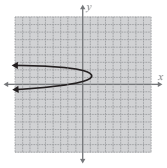
23. **a.** $\left(-\frac{1}{4}, -\frac{9}{8}\right)$ **b.** $(0, -1)$
c. $x = -\frac{1}{4}$



25. **a.** $\left(\frac{9}{8},\frac{5}{4}\right)$

b. $\left(0,\frac{1}{2}\right),(0,2)$

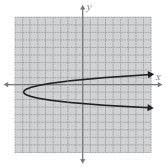
c. $y=\frac{5}{4}$



27. **a.** $(-8,-1)$

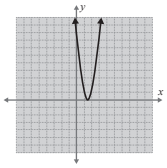
b. $\left(0,-1+\frac{2\sqrt{6}}{3}\right)$, $\left(0,-1-\frac{2\sqrt{6}}{3}\right)$

c. $y=-1$

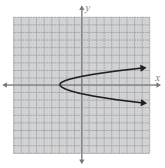


29. **a.** $\left(\frac{3}{2},0\right)$ **b.** $(0,9)$

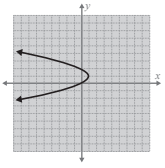
c. $x=\frac{3}{2}$



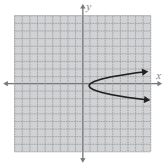
31. $(0,1.225),(0,-1.225)$



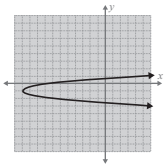
33. $(0,2),(0,0)$



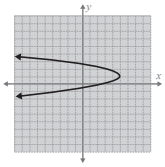
35. No y-intercept



37. $(0,0.658),(0,-2.658)$



39. $(0,2.581),(0,-0.581)$



41. b

43. c

Writing & Thinking

45. If $|a|<1$, then the parabola will be wider than the graph of $x=y^2$. If $|a|>1$, then the parabola will be narrower than the graph of $x=y^2$.

16.3 Exercises

Concept Check

1. $\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$

3. averaging

5. twice

7. True

9. True

Practice

1. $5;(4,5.5)$

3. $13;(3,4.5)$

5. $\sqrt{29};(2,4.5)$

7. $3;(5.5,-3)$

9. $\sqrt{13};(6,-3.5)$

11. $17;(-3,-4.5)$

13. $x^2+y^2=16$

15. $x^2+y^2=3$

17. $x^2+y^2=11$

19. $x^2+y^2=\frac{4}{9}$

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

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

25. $(x+2)^2+y^2=8$

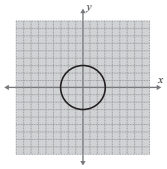
27. $(x-3)^2+(y-1)^2=36$

29. $(x-3)^2+(y-5)^2=12$

31. $(x-7)^2+(y-4)^2=10$

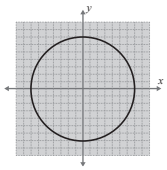
33. $x^2+y^2=9$

Center: $(0,0)$; $r=3$



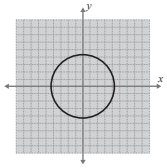
35. $x^2+y^2=49$

Center: $(0,0)$; $r=7$



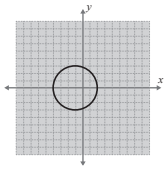
37. $x^2+y^2=18$

Center: $(0,0)$; $r=3\sqrt{2}$



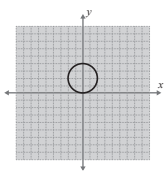
39. $(x+1)^2+y^2=9$

Center: $(-1,0)$; $r=3$



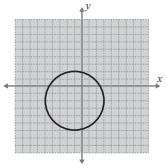
41. $x^2+(y-2)^2=4$

Center: $(0,2)$; $r=2$



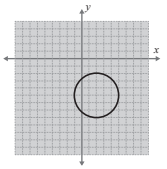
43. $(x+1)^2+(y+2)^2=16$

Center: $(-1,-2)$; $r=4$



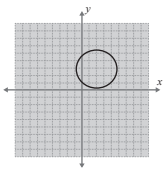
45. $(x-2)^2+(y+5)^2=9$

Center: $(2,-5)$; $r=3$



47. $(x-2)^2+(y-3)^2=8$

Center: $(2,3)$; $r=2\sqrt{2}$



49. $\overline{AB}=3\sqrt{5},\overline{AC}=\sqrt{65},\overline{BC}=2\sqrt{5}$, $(3\sqrt{5})^2+(2\sqrt{5})^2=(\sqrt{65})^2$; Right triangle

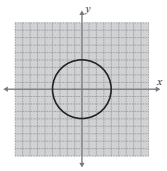
51. $\overline{AB}=\overline{AC}=4\sqrt{5}$

53. $\overline{AB}=\overline{AC}=\overline{BC}=4$

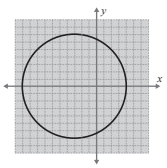
55. $\overline{AC}=\overline{BD}=\sqrt{61}$

57. $10+4\sqrt{5}$

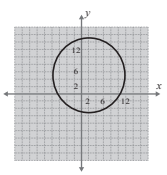
59.



61.



63.



Applications

65. 10 blocks

67. $\sqrt{20} = 2\sqrt{5}$ hundred yards

Writing & Thinking

69. **a.** $d = \sqrt{x^2 + (y-p)^2}$

b. $d = |y + p|$

c. $y + p = \sqrt{x^2 + (y-p)^2}$

$$(y+p)^2 = x^2 + (y-p)^2$$
$$y^2 + 2py + p^2 = x^2 + y^2 - 2py + p^2$$
$$x^2 = 4py$$

71. **a.** $d = \sqrt{(x-p)^2 + y^2}$

b. $d = |x + p|$

c.

$$x + p = \sqrt{(x-p)^2 + y^2}$$
$$(x+p)^2 = (x-p)^2 + y^2$$
$$x^2 + 2px + p^2 = x^2 - 2px + p^2 + y^2$$
$$y^2 = 4px$$

16.4 Exercises

Concept Check

1. oval

3. focus

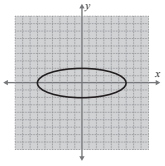
5. minor

7. True

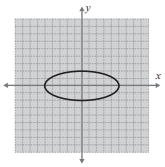
9. False; The midway point between the foci is the center.

Practice

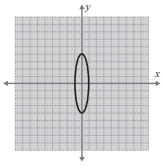
1. $\frac{x^2}{36} + \frac{y^2}{4} = 1$



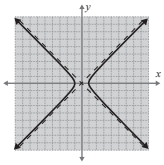
3. $\frac{x^2}{25} + \frac{y^2}{4} = 1$



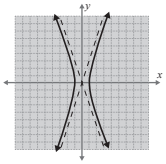
5. $\frac{x^2}{1} + \frac{y^2}{16} = 1$



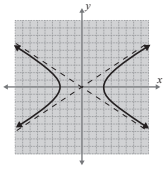
7. $\frac{x^2}{1} - \frac{y^2}{1} = 1$



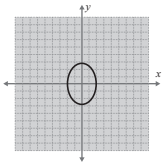
9. $\frac{x^2}{1} - \frac{y^2}{9} = 1$



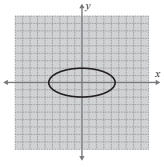
11. $\frac{x^2}{9} - \frac{y^2}{4} = 1$



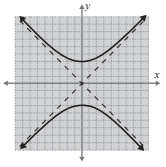
13. $\frac{x^2}{4} + \frac{y^2}{8} = 1$



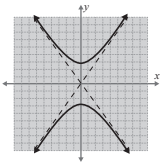
15. $\frac{x^2}{20} + \frac{y^2}{4} = 1$



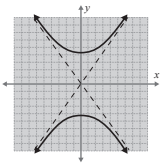
17. $\frac{y^2}{9} - \frac{x^2}{9} = 1$



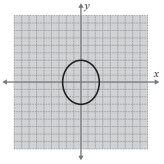
19. $\frac{y^2}{8} - \frac{x^2}{4} = 1$



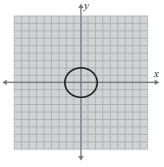
21. $\frac{y^2}{18} - \frac{x^2}{9} = 1$



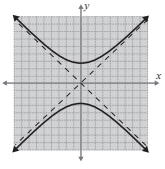
23. $\frac{x^2}{6} + \frac{y^2}{9} = 1$



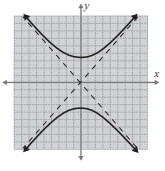
25. $\frac{x^2}{5} + \frac{y^2}{4} = 1$



27. $\frac{y^2}{8} - \frac{x^2}{9} = 1$



29. $\frac{y^2}{12} - \frac{x^2}{9} = 1$

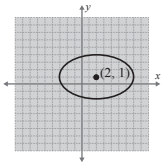


31. e

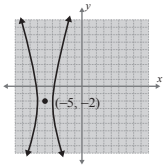
33. d

35. b

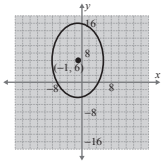
37.



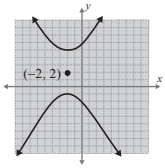
39.



41.



43.



Writing & Thinking

45. **b.** Pick an arbitrary point (x, y) located on the ellipse. The sum of the distances from (x, y) to the points $(-c, 0)$ and $(c, 0)$ (the foci) will equal $2a$. Using the distance formula we get the equation $\sqrt{(x+c)^2 + (y-0)^2} + \sqrt{(x-c)^2 + (y-0)^2} = 2a$. Now to remove the radicals, simplify so that one side of the equation is a single radical and square both sides. Then repeat the previous step and simplify. This gives $\frac{x^2}{a^2} + \frac{y^2}{a^2 - c^2} = 1$.

c. At the y-intercept $(0, b)$ a right triangle is formed with hypotenuse a and sides b and c. The Pythagorean Theorem gives $a^2 = b^2 + c^2$.

16.5 Exercises

Concept Check

1. second

3. substitution, addition

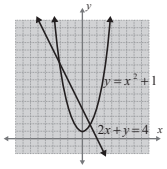
5. both

7. True

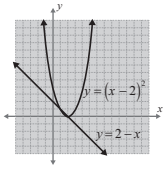
9. False; There are many situations where the curves do not intersect.

Practice

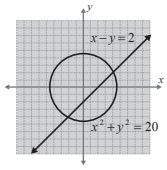
1. $(-3, 10), (1, 2)$



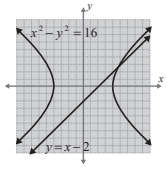
3. $(1, 1), (2, 0)$



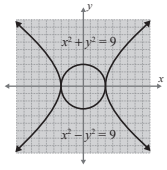
5. $(-2, -4), (4, 2)$



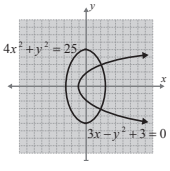
7. $(5, 3)$



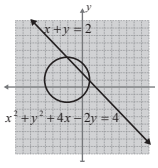
9. $(-3, 0), (3, 0)$



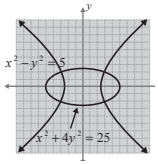
11. $(2, 3), (2, -3)$



13. $(-2, 4), (1, 1)$



15. $(-3, -2), (3, 2), (-3, 2), (3, -2)$



17. $\left(-3\sqrt{5}, 5\right), (-6, 4), \left(3\sqrt{5}, 5\right), (6, 4)$

19. $(1, 3), (-1, 3)$

21. $(4, 4), (-2, -2)$

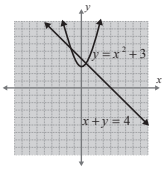
23. $\left(-\frac{3}{2}, -1\right), \left(\frac{1}{2}, \frac{1}{2}\right)$

25. $\left(-3, \sqrt{11}\right), \left(-3, -\sqrt{11}\right), \left(3, \sqrt{11}\right), \left(3, -\sqrt{11}\right)$

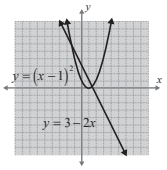
27. $(5, -3), (-5, 1)$

29. $(0, 3), (2, 3)$

31. $(-1.62, 5.62), (0.62, 3.38)$



33. $(1.41, 0.17), (-1.41, 5.83)$



35. $(2.68, 1.68), (-1.68, -2.68)$