

Answer Key

Chapter 1: Whole Numbers

1.1 Exercises

Concept Check

1. 1
3. Counting
5. $5000 + 0 + 10 + 2$
7. True
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. $30 + 7$
11. $500 + 60 + 3$
13. $1000 + 800 + 90 + 2$
15. $20,000 + 5000 + 600 + 50 + 8$
17. Eight hundred thirty-five
19. Thirty thousand, two
hundred one
21. Six hundred eighty-three
thousand, one hundred
23. Sixteen million, three
hundred two thousand,
five hundred ninety
25. 580
27. 2005
29. 3834
31. 78,902
33. 63,065
35. 400,736
37. 82,700,000
39. 35,960,013

Applications

41. Eighty-two thousand, one
hundred three
43. One hundred ten; two
thousand six hundred fifty
45. Three hundred fifty-two
thousand, one hundred
forty-three; nine hundred
twelve thousand, fifty
47. Ten thousand, six hundred
sixty-seven; sixty-six
thousand, four hundred
ninety-six
49. 8520; 2000
51. 44; 218,792
53. 193,046; 184,327
55. 10,533,871; 3,154,000
57. No; 480,105
59. Sam Burns
61. Will Zalatoris
63. Seven million, twelve
thousand, six hundred
seventy-two
65. *Wicked*
67. *Plaza Suite*, seven
thousand, seven hundred
ninety-one
69. *Plaza Suite*, *Moulin
Rouge! The Musical*, *MJ
The Musical*, and *Six*
71. *Wicked*
73. $40,000,000 + 7,000,000 + 500,000 + 40,000 + 7000 + 200 + 30 + 1$
75. \$183,651,655; One hun-
dred eighty-three million,
six hundred fifty-one
thousand, six hundred
fifty-five dollars

Writing & Thinking

77. 10^{100}
79. 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, $125 \leq 125$

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 fac-
tors.
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. 900
 43. 2500
 45. 4000
 47. 160,000
 49. 1,500,000
 51. 320,000,000
 53. $3 \cdot 9 + 3 \cdot 7 = 27 + 21 = 48$
 55. $6 \cdot 3 + 6 \cdot 11 = 18 + 66 = 84$
 57. 25 square yards
 59. 63 square meters
 61. 216 square yards

Applications

63. \$2975
 65. 360 minutes;
 2520 minutes
 67. 9250 calories
 69. \$284,400
 71. 234
 73. \$23
 75. 648 square feet
 77. 10,080 square feet

Writing & Thinking

79. Zero times any number is 0.
 81. 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.

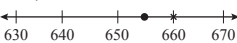
1.5 Exercises

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. 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. 1.024E13, 1E20; Answers will vary.

1.8 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.

1.9 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. a. 700 has 18 factors. They are: 1, 2, 4, 5, 7, 10, 14, 20, 25, 28, 35, 50, 70, 100, 140, 175, 350, and 700.

b. 660 has 24 factors.

They are: 1, 2, 3, 4, 5, 6, 10, 11, 12, 15, 20, 22, 30, 33, 44, 55, 60, 66, 110, 132, 165, 220, 330, and 660.

c. 450 has 18 factors.

They are: 1, 2, 3, 5, 6, 9, 10, 15, 18, 25, 30, 45, 50, 75, 90, 150, 225, and 450.

Chapter 2: Fractions and Mixed Numbers

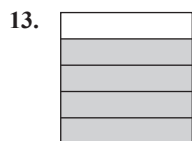
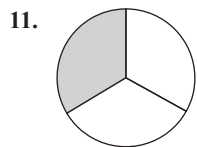
2.1 Exercises

Concept Check

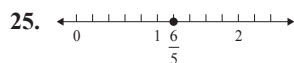
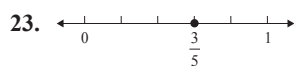
1. improper
3. mixed
5. False; The numerator is 11.
7. True

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. $\frac{23}{30}$



15. $\frac{5}{4}$
17. $\frac{10}{4}$
19. 0
21. Undefined



27. Mixed number

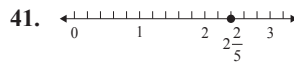
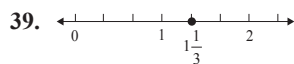
29. Proper fraction

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.



43. $\frac{8}{5}$ 45. $\frac{9}{4}$

47. $\frac{68}{10}$ 49. $\frac{37}{8}$

51. $\frac{34}{7}$ 53. $\frac{17}{15}$

55. $\frac{128}{12}$ 57. $\frac{701}{100}$

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

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

67. $4\frac{5}{8}$ 69. 3

71. $1\frac{15}{20}$ 73. $1\frac{85}{100}$

Applications

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

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.

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. $\frac{1}{16}$ 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. $\frac{1}{6}$
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. $\frac{12}{35}$
37. $\frac{1}{2}$ 39. $\frac{2}{3}$
41. $\frac{2}{3}$ 43. $\frac{25}{76}$
45. 4 47. $\frac{6}{25}$
49. $\frac{3}{7}$ 51. $\frac{12}{13}$
53. $\frac{10}{9}$ 55. $\frac{3}{2}$

2.2 Exercises

Concept Check

1. 1
3. factors
5. common
7. True

57. $\frac{1}{4}$ 59. $\frac{8}{9}$

61. $\frac{4}{35}$ 63. $\frac{1}{3}$

65. $\frac{9}{16}$ 67. 1

69. $\frac{5}{77}$ 71. $\frac{1}{6}$

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

75. $\frac{28}{45}$

77. $\frac{21}{16}$ or $1\frac{5}{16}$

79. $\frac{9}{4}$

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.

2.3 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. $\frac{7}{12}$

11. $\frac{8}{9}$

13. $\frac{5}{7}$

15. 0

17. Undefined

19. $\frac{7}{5}$ 21. $\frac{1}{3}$

23. $\frac{7}{6}$ 25. $\frac{4}{9}$

27. $\frac{7}{16}$ 29. $\frac{10}{9}$

31. $\frac{4}{5}$ 33. $\frac{8}{3}$

35. 1 37. $\frac{32}{21}$

39. $\frac{10}{3}$ 41. $\frac{12}{35}$

43. $\frac{7}{60}$ 45. $\frac{7}{5}$

47. $\frac{41}{12}$ 49. $\frac{5}{7}$

51. 98

Applications

53. $\frac{12}{25}$
55. 200 years
57. a. More b. Less
c. 200 passengers

59. a. More b. Less

- c. 8000 steel rods per week

Writing & Thinking

61. $0 = \frac{0}{1}$ and the reciprocal would be $\frac{1}{0}$ but division by 0 is undefined. So 0 has no reciprocal.
63. $12 \div 3 = 4$ 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.
65. No. For example, $\frac{4}{5} \neq \frac{5}{4}$. Answers will vary.

2.4 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. $7\frac{1}{2}$ ft²

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 per hour

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

Writing & Thinking

83. Change each mixed number to an improper fraction and then multiply the two fractions. Then, change the result to a mixed number. For example,
 $2\frac{1}{11} \cdot 5\frac{1}{2} = \frac{23}{11} \cdot \frac{11}{2} = \frac{23}{2} = 11\frac{1}{2}$.
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.)

2.5 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. 200 15. 150
17. 40 19. 112
21. 196 23. 66
25. 10 27. 36
29. 60 31. 90
33. 120
35. a. LCM = 150
b. $150 = 10 \cdot 15$
 $= 15 \cdot 10 = 25 \cdot 6$
37. a. LCM = 120
b. $120 = 6 \cdot 20$
 $= 24 \cdot 5 = 30 \cdot 4$
39. a. LCM = 108
b. $108 = 12 \cdot 9$
 $= 18 \cdot 6 = 27 \cdot 4$
41. a. LCM = 2520
b. $1260 = 20 \cdot 63$
 $= 28 \cdot 45 = 45 \cdot 28$
43. 15 45. 4
47. 42 49. 15
51. 40 53. 60
55. 44 57. 32
59. 81 61. 90
63. 42 65. 110

Applications

67. a. 60 minutes
b. 4, 3, and 2 trips, respectively
69. a. 90 hours
b. 6 and 5 orbits, respectively
71. a. 840 days
b. 105, 70, 60, and 56 trips, respectively
73. a. 840 seconds
b. 24 laps, 21 laps, and 20 laps, respectively
75. a. 120 hours
b. 15 orbits and 8 orbits, respectively

77. Every 180 days

79. 60 years

81. \$12

Writing & Thinking

83. Since the LCM is constructed using the prime factors of each number in the set, by definition, each number will divide the LCM.
85. 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.

2.6 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. $\frac{5}{14}$ 3. 2
5. $\frac{1}{5}$ 7. $\frac{3}{4}$
9. $\frac{7}{9}$ 11. $\frac{11}{8}$
13. $\frac{62}{45}$ 15. $\frac{13}{12}$
17. $\frac{3}{4}$ 19. $\frac{7}{10}$
21. 1 23. $\frac{17}{20}$
25. $\frac{5}{6}$ 27. $\frac{11}{20}$
29. $\frac{17}{20}$ 31. $\frac{317}{1000}$
33. $\frac{631}{100}$ 35. $\frac{3}{5}$
37. $\frac{1}{3}$ 39. $\frac{8}{13}$
41. $\frac{1}{2}$ 43. $\frac{13}{30}$
45. $\frac{3}{5}$ 47. $\frac{1}{12}$
49. $\frac{5}{16}$ 51. $\frac{13}{20}$
53. $\frac{11}{18}$ 55. $\frac{1}{10}$
57. $\frac{23}{16}$ 59. 0
61. $\frac{3}{50}$ 63. $\frac{1}{50}$

Applications

65. 1 ounce
67. $\frac{23}{20}$ inches
69. $\frac{5}{8}$ inch
71. a. $\frac{5}{18}$ b. \$6000
73. $\frac{7}{24}$
75. $\frac{11}{36}$
77. a. $\frac{3}{4}$
b. 0 (the pie is totally consumed)
79. $\frac{23}{45}$ of the assignment

$$81. \frac{1}{10}$$

Writing & Thinking

83. 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.
85. 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.

2.7 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. $28\frac{1}{2}$
5. $14\frac{5}{7}$ 7. $7\frac{2}{3}$
9. $10\frac{3}{8}$ 11. $8\frac{10}{21}$
13. $5\frac{17}{26}$ 15. $9\frac{3}{4}$
17. $8\frac{2}{3}$ 19. $9\frac{29}{40}$
21. $12\frac{7}{27}$ 23. $12\frac{17}{24}$
25. $12\frac{47}{60}$ 27. $4\frac{2}{3}$
29. $9\frac{7}{20}$ 31. $4\frac{1}{2}$
33. 4 35. $4\frac{3}{5}$

37. $3\frac{5}{8}$ 39. $6\frac{1}{6}$
 41. $3\frac{11}{20}$ 43. $6\frac{7}{12}$
 45. $16\frac{5}{24}$ 47. $\frac{1}{4}$
 49. $1\frac{1}{8}$ 51. $\frac{1}{3}$
 53. $12\frac{9}{70}$ 55. $3\frac{29}{32}$
 57. $12\frac{25}{28}$ 59. $2\frac{16}{21}$

Applications

61. $8\frac{7}{12}$ hours
 63. $12\frac{1}{8}$ inches
 65. \$900 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

2.8 Exercises

Concept Check

1. Numerators
 3. Multiplication, division
 5. Divide
 7. False; According to the rules for order of operations, multiplication and division occur from left to right.

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. $\frac{21}{25}$ by $\frac{11}{400}$
 13. $\frac{11}{48}$ by $\frac{1}{60}$
 15. $\frac{3}{8}, \frac{2}{5}, \frac{1}{2}, \frac{1}{8}$
 17. $\frac{1}{4}, \frac{1}{3}, \frac{1}{2}, \frac{1}{4}$

19. $\frac{7}{9}, \frac{31}{36}, \frac{17}{18}, \frac{1}{6}$
 21. $\frac{8}{9}, \frac{9}{10}, \frac{11}{12}, \frac{1}{36}$
 23. $\frac{5}{42}, \frac{1}{3}, \frac{3}{7}, \frac{13}{42}$
 25. $\frac{20}{10,000}, \frac{3}{1000}, \frac{1}{100}, \frac{1}{125}$
 27. $\frac{2}{3}$
 29. $\frac{1}{5}$
 31. $\frac{19}{4} = 4\frac{3}{4}$
 33. $\frac{1}{4}$
 35. $\frac{89}{9} = 9\frac{8}{9}$
 37. $\frac{8}{39}$
 39. $\frac{5}{7}$
 41. $\frac{15}{64}$
 43. $\frac{14}{45}$
 45. $\frac{5}{3} = 1\frac{2}{3}$
 47. $\frac{3}{16}$
 49. $\frac{29}{36}$
 51. 1
 53. $\frac{1}{5}$
 55. $\frac{138}{65} = 2\frac{8}{65}$
 57. $\frac{172}{9} = 19\frac{1}{9}$

59. $\frac{5}{6}$
 61. $\frac{791}{120} = 6\frac{71}{120}$
 63. $\frac{63}{19} = 3\frac{6}{19}$
 65. $\frac{3}{2} = 1\frac{1}{2}$
 67. $\frac{22}{45}$
 69. $\frac{47}{40} = 1\frac{7}{40}$
 71. $\frac{223}{32} = 6\frac{31}{32}$
 73. $\frac{2123}{360} = 5\frac{323}{260}$

Applications

75. $\frac{543}{40} = 13\frac{23}{40}$
 77. 43 inches
 79. 375
 81. 17 pounds
 83. a. $\frac{1}{3}$ kg b. \$6
 85. $\frac{91}{48} = 1\frac{43}{48}$ feet

Writing & Thinking

87. 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.
 89. a. Less than b. Less than

Chapter 3: Decimal Numbers

3.1 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. 17.9

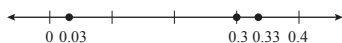
25. 0.23 27. 6.028

29. 0.4502 31. 0.27

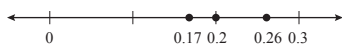
33. 0.163 35. 24.295

37. 0.01

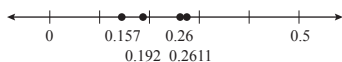
39.



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.

3.2 Exercises

Concept Check

1. vertically

3. whole

5. True

7. False; In subtracting decimal numbers, line up the decimal points and corresponding digits vertically.

Practice

1. 50.085 3. 7.8798

5. 599.07 7. 156.305

9. 237.74 11. 9.83

13. 72.31 15. 11.5

17. 19.541 19. 40.313

21. 11.131 23. 17.8

25. 2.13 27. 32.7

29. 45.01 31. 4.7974

33. 8.93 35. 1.44

37. 0.9757 39. 4.895

41. 28.475 43. 2.9434

45. 17.5616 47. 10 cm

49. 61.2 cm 51. 18.84 m

Applications

53. a. \$94.85 b. \$5.15

55. 82.83 feet

57. \$671.75

59. a. 39.9 million

b. 31.9 million

61. a. 6.97 feet b. 2.73 feet

63. a. 12.15 gallons

b. 3.25 gallons

65. \$6089.90

67. 12.1778 tons

69. No, he is short \$0.19.

71. a. 758.99909 sec

b. 761.00073 sec

73. 0.02458 liter

75. a. \$67.22

b. \$32.78

Writing & Thinking

77. 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.

79. a. Answers will vary.

b. Answers will vary.

81. Sophia did not align the decimal points in the addends vertically, so she was not adding corresponding place values.

3.3 Exercises

Concept Check

1. whole numbers

3. 3, right

5. 10, 100, 1000

7. True

9. False; Multiplying by 100 requires that the decimal point be moved 2 places to the right.

Practice

1. 0.42 3. 0.04

5. 21.6 7. 0.42

9. 0.004 11. 0.108

13. 0.073 15. 0.0276

17. 0.0486 19. 0.0034

21. 0.3375 23. 1.500

25. 1.4000 27. 3.975

29. 1.200 31. 5.063

33. 0.0648 35. 0.18

37. 65.3980 39. 0.04336

41. 4.35 43. 346

45. 1610 47. 4178.2

49. 380 51. 7.9

53. 61.5 55. 50

Applications

57. 12.8 ft; 10.24 ft²59. 26.6 cm; 29.40 cm²

61. \$240.90

63. \$936,945

65. \$621.40

67. 2.8926 in.

69. \$932.60

71. Discount: \$45.30;
Total: \$288.67

73. \$1320

Writing & Thinking

75. In multiplication with decimal numbers, placement of the decimal point must be considered. Otherwise, multiplication with whole numbers and decimal numbers are the same.

3.4 Exercises

Concept Check

1. whole

3. whole numbers

5. left

7. True

9. False; Dividing by a power of 10 involves dividing by 10, 100, 1000, etc.

Practice

1. 2.34 3. 0.57

5. 0.18 7. 0.08

9. 2.36 11. 2056

13. 6.54 15. 20

17. 56.9 19. 0.7

21. 0.9 23. 728.7

25. 21.0 27. 0.01

29. 5.78 31. 12.12

33. 0.56 35. 3.8

37. 13.81 39. 0.785

41. 0.794
43. 0.5036
45. 3.164963
47. 0.0186
49. 0.045621
51. 1.17385
53. 0.000154

Applications

55. \$239.56
57. \$295
59. 5630 at bats
61. 4.4 yards per carry
63. 67.92

Writing & Thinking

65. In division with decimal numbers, placement of the decimal point must be considered. Also, with whole numbers a remainder is considered while, with decimal numbers, rounding the quotient is considered. Otherwise, division with whole numbers and decimal numbers are the same.
67. Answers will vary.

3.5 Exercises

Concept Check

- leftmost
- decimal point
- exponential expressions
- False; When estimating the product of decimal numbers, round the numbers to the leftmost nonzero digit.
- True

Practice

- 34; 32.82
- 19; 21.79
- 106; 102.46
- 3; 3.31

- 188; 207.45
- 20; 26.08
- 1; 1.55
- 10; 9.09
- 2.4; 2.621
- 7000; 6548.06
- 6; 4.86
- 0.72; 0.7452
- 6; 6.2144
- 5; 5.17
- 2; 2.032
- 0.06; 0.0486
- 5.4; 4.9077
- 2; 2.05
- 10; 9.45
- 10,000; 9446.67
- 2000; 2115
- 75; 78.44
- 3.5; 3.09
- 0.2; 0.24
- 4.75
- 15.26
- 62.12
- 13.7
- 26.88

Applications

- a. 39 pounds
b. 35.43 pounds
- a. 15 feet b. 15.03 feet
- a. \$5000 b. \$5959.80
- a. \$900 b. \$891.50
c. \$10,698.00
- a. 600 miles b. 480.7
- a. \$4 per pound
b. \$5.11 per pound
- a. 15 mpg b. 22 mpg
- a. \$740 b. \$772
- a. \$99 b. \$98.32
c. \$49.16

Writing & Thinking

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

3.6 Exercises

Concept Check

- numerator, denominator
- repeating, nonrepeating
- terminating
- True
- False; In some cases, fractions can be converted to decimal form without losing accuracy.

Practice

- $\frac{9}{10}$
- $\frac{51}{10}$
- $\frac{1}{5}$
- $\frac{9}{40}$
- $\frac{25}{4}$ or $6\frac{1}{4}$
- 0.05
- 0.6
- 6.67
- 0.03
- 0.7
- 1.13
- 6.50
- 120.31
- 1.16
- $\frac{526}{1000}$
- $\frac{815}{100}$
- $\frac{9}{50}$
- 0.625
- 0.27
- 0.48
- 1.43
- 11.59
- 1
- 23.41
- 2.64
- 1.80
- 0.28 is larger; 0.0072
- 3.3 is larger; 0.1571428

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

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

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

Applications

- $93\frac{4}{5}$
- $30\frac{3}{10}; 28\frac{2}{5}$
- $21\frac{1}{2}$
- 0.58
- 2.9
- 17.92 inches
- 20.2 miles
- 60 students that drive to school and have a job are taking AP English
- 0.9 ounces
- 25 slides

Writing & Thinking

83. 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.
85. This problem could be solved by converting all numbers to fractions or all numbers to decimal numbers. Answers will vary.

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. 113.7¢/oz; 66.6¢/oz
12 oz at \$7.99
43. 250¢/pair; 275¢/pair
5 pairs at \$12.50
45. 33.3¢/oz; 36.1¢/oz
12 oz at \$3.99
47. 19.9¢/oz; 16.8¢/oz
12.2¢/oz; 10.6¢/oz
64 oz at \$6.79

49. $\frac{3 \text{ fat grams}}{10 \text{ grams}}$
51. $\frac{12 \text{ clear days}}{61 \text{ cloudy days}}$
53. $\frac{4}{5}$
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. \$62.50 per person
77. We can expect the player to get 3 hits for every 10 times at bat.
79. 50 trash bags for \$25.98
81. \$0.53 per pound
83. \$0.25 per can
85. \$0.36 per ounce
87. a. 31.5 miles per gallon
b. No; 31.5 miles per gallon is lower than the advertised amount.
89. 63 miles per hour is lower than the posted speed limit.

- 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.

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.

1. True
5. True
9. False
13. True
17. True
21. $x = 10$
25. $D = 100$
27. $A = \frac{21}{2}$ or 10.5
29. $x = 1$
31. $y = 6$
33. $x = \frac{1}{4}$ or 0.25
35. $R = 50$
37. $A = 27.3$
39. $B = 6.75$
41. $B = 7.8$
43. $x = 1.5$
45. $B = 90$
47. $x = 25$ hr
3. True
7. True
11. True
15. False
19. False
23. $x = 50$

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. \$4.17
67. $1\frac{1}{2}$ cups or 1.5 cups
69. 33 hits
71. 437.5 grams
73. 20 yards
75. \$400
77. 9 hours
79. 118.8 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
- $$\frac{300 \text{ miles}}{4 \text{ inches}} = \frac{750 \text{ miles}}{x}.$$

- ### 4.3 Exercises

- Concept Check**
- 83
 - 2; right
 - True

7. False; A decimal number that is between 0.01 and 0.10 is between 1% and 10%.

Practice

1. 60% 3. 65%
 5. 12.5% 7. 100%
 9. 20% 11. 9%
 13. 15% 15. 125%
 17. 13.4% 19. 0.48%
 21. 0.5% 23. 2.14%
 25. 2% 27. 10%
 29. 36% 31. 40%
 33. 2.5% 35. 0.5%
 37. 12.8% 39. 112%
 41. 230% 43. 200%
 45. 0.02 47. 0.18
 49. 0.25 51. 0.2
 53. 1.25 55. 1.2
 57. 0.065 59. 0.173
 61. 0.0026 63. 0.0137

Applications

65. 12% 67. 2%
 69. 6.5% 71. 0.085
 73. 0.45 75. 5.23

Writing & Thinking

77. Percent means per centum or per 100. For example, fifty-eight percent means 58 out of 100. Percent can be written as a fraction with 100 in the denominator as in $\frac{58}{100}$. The decimal equivalent, 0.58 is read as "fifty-eight hundredths," indicating percent can be written using the hundredths place, another connection..
79. Both conversions involve moving the decimal point two places. The difference is whether the decimal point moves left or right. When changing a percent to decimal, the decimal point moves two places to the left and when changing a decimal to a percent, the decimal point moves two places to the right.

4.4 Exercises

Concept Check

1. 100
 3. 2; right
 5. False; Fractions that have denominators other than 100 can be changed to a percent.
 7. False; When changing from a percent to a mixed number, the fraction should be reduced.

Practice

1. 3% 3. 16%
 5. 50% 7. 75%
 9. 5% 11. 40%
 13. 26% 15. 87.5%
 17. 4% 19. 12.5%
 21. 58.3% 23. 116.7%
 25. 125% 27. 105%
 29. 210% 31. 206.7%

33. $\frac{1}{20}$ 35. $\frac{3}{20}$
 37. $\frac{17}{100}$ 39. $\frac{1}{4}$
 41. $\frac{33}{100}$ 43. 1
 45. $1\frac{1}{5}$ 47. $1\frac{1}{4}$
 49. $\frac{1}{8}$ 51. $\frac{3}{400}$
 53. $\frac{1}{200}$ 55. $\frac{1}{8}$
 57. $\frac{1}{6}$ 59. $\frac{1}{3}$
 61. a. 0.625 b. 62.5%

63. a. $\frac{9}{100}$ b. 9%
 65. a. $\frac{9}{25}$ b. 0.36

Applications

67. $\frac{7}{20}$
 69. $\frac{6}{25}$
 71. $\frac{16}{125}$

73. $\frac{7}{20,000}$

75. 4%
 77. 0.000075%
 79. a. 0.0011 b. 0.11%
 c. Yes
 81. 9.8%

Writing & Thinking

83. $100\% = 1$ 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%.

4.5 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.

4.6 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."

4.7 Exercises

Concept Check

- look back or check
- (total) sale or selling
- appreciation
- True
- 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. \$2520
 29. \$112,700
 31. \$10,000
 33. 5.9%
 35. 2.484%
 37. 215,966 people
 39. a. \$200.00 b. 11.11%
 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.

4.8 Exercises

Concept Check

- interest
- simple
- quarterly
- True
- 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.

Chapter 5: Measurement

5.1 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.

5.2 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 cm²
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.

5.3 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 ton 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 cm³

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.

5.4 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 ft²
 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 m²
 81. a. 11 145.6 cm²

b. 1.116 m²

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.

Chapter 6: Geometry

6.1 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. $m\angle 2 = 138^\circ$;
 $m\angle 3 = 42^\circ$
 $m\angle 4 = 138^\circ$

21. a. $m\angle 2 = 70^\circ$;
 $m\angle 3 = 90^\circ$;
 $m\angle 4 = 20^\circ$;
 $m\angle 5 = 70^\circ$
 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. $m\angle 7 = 125^\circ$; $\angle 6$ 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. $m\angle Z = 80^\circ$
 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

6.2 Exercises

Concept Check

1. polygon
3. rectangle
5. triangle
7. a. True
b. False; Not all rectangles have four equal sides.
9. True
11. a. B b. C c. A
d. E e. D

Practice

1. 44 cm 3. 116 cm
5. 18 km 7. 143 in.
9. 48.1 yd 11. 40 cm
13. 45 cm 15. 34 cm
17. 200 yd 19. 36 cm
21. 35 ft 23. 43 cm
25. 36 m 27. 40 ft
29. 50 in. 31. 108 ft

Applications

33. 114 cm
35. 38.4 in.
37. a. 4605 ft
b. 15.7 minutes
39. a. 548 feet b. \$8220
41. $13\frac{4}{5}$ inches
43. $17\frac{1}{2}$ km

Writing & Thinking

45. Some of the polygons are: triangle (3 sides), square (4 sides), rectangle

(4 sides), parallelogram (4 sides), and trapezoid (4 sides).

47. 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 ($P = 2a + 2b$).

6.3 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 ft²
3. 525 km²
5. 27.37 ft²
7. $\frac{5}{27}$ in.²
9. 165 cm²
11. 48 in.²
13. 99 ft²
15. 162 yd²
17. 1925 cm²
19. 196 in.²
21. 48 cm²
23. 160 in.²
25. 60 in.²
27. 107 m²
29. 99 in.²

31. 220 mm²
33. 36 cm²
35. 192 m²
37. 99 in.²
39. a. 12 ft; 6 ft²
b. 30 cm; 30 cm²
c. 48 in.; 96 in.²
41. a. 70 cm b. 220 cm²
43. a. 32 m b. 48 m²

Applications

45. 204 square feet
47. 3136 square inches.
49. a. 30 ft² b. 30 ft
51. a. 2350 square feet
b. 11.75 pounds
53. 123 square feet
55. 426 square meters

Writing & Thinking

57. The expression $(b + c)$ represents the sum of the two bases in a trapezoid. The bases are the two sides that are parallel in a trapezoid.
59. The area of the interior triangle is equal to half of the area of the rectangle no matter where the point is chosen.

6.4 Exercises

Concept Check

1. diameter
3. radius
5. π
7. True
9. False; The length of the radius of a circle is half of the length of the diameter.

Practice

1. a. 31.4 ft b. 78.5 ft²
3. a. 19.468 yd
b. 30.1754 yd²

5. a. 3.14 m b. 0.785 m²
7. a. 188.4 cm b. 2826 cm²
9. a. 4.71 ft b. 1.76625 ft²
11. a. 37.68 cm
b. 113.04 cm²
13. a. 94.2 in. b. 706.5 in.²
15. a. 35.98 in.
b. 76.93 in.²
17. a. 10.71 cm
b. 7.065 cm²

19. a. 13.71 in.
b. 12.5325 in.²

21. a. 21.42 m b. 32.13 m²
23. a. 14.28 m b. 11.14 m²
25. a. 19.42 cm
b. 26.13 cm²
27. a. 36.56 m b. 38.88 m²
29. 7536 m²
31. 0.86 m²

Applications

33. a. 63.6 square inches
b. \$0.13 per square inch
35. a. 61.68 in.
b. 226.08 in.²
37. 15,307.5 ft²
39. 314.96 in.²
41. a. 4.57 square feet
b. 10.34 feet
43. 62,800 in. (a little less than one mile)
45. 90.7 in.²
47. 4710 ft

Writing & Thinking

49. One diameter is equal to two radii. Thus, $d = 2r$ and $C = 2\pi r = \pi d$.
51. Pi is a nonrepeating nonterminating decimal and therefore, when using π , a rounded number must be used for calculations. Anytime a rounded number is used in calculations, the result will be an approximation.

Collaborative Learning

53. a. 4

b. Answers will vary somewhat, but they should be about 3.3.

c. Answers will vary. The numbers will be come closer to π as the number of sides increases.

6.5 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 cm³
5. 12.56 mm³
7. 60 in.³
9. 14.13 ft³
11. 401.92 m³
13. 376.8 ft³
15. 2289.06 cm³
17. 224 cm³
19. 113.04 in.³
21. 9106 dm³
23. 56.52 ft³
25. 1017.36 mm²
27. 122 in.²
29. 226.08 m²
31. $V = 70 \text{ in.}^3$;
 $V = 1147.09 \text{ cm}^3$
33. $V = 12.56 \text{ dm}^3$;
 $V = 0.01256 \text{ m}^3$

Applications

35. 2,596,902 m³
37. 10.39 in.³
39. 800 ft³
41. 13 cm

43. a. 3.375 ft³ b. 13.5 ft²

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.

6.6 Exercises

Concept Check

1. shape
3. proportional
5. False; Similar triangles have corresponding sides that are proportional.
7. False; If $\triangle ABC \cong \triangle DEF$, then $AC = DF$.

Practice

1. The triangles are not similar. The corresponding sides are not proportional.
3. $\triangle PQR \sim \triangle SUT$. All pairs of corresponding sides are proportional to the ratio 1:2.
5. $\triangle ABC \sim \triangle EDC$. The corresponding angles have the same measure.
7. $x = 50^\circ$; $y = 70^\circ$
9. $x = 50^\circ$; $y = 50^\circ$
11. $x = 20^\circ$; $y = 100^\circ$
13. $x = 4.8$; $y = 7.2$
15. $x = 7.5$; $y = 15$
17. $x = 6$; $y = 4$
19. $x = 95^\circ$; $y = 20$
21. $x = 25^\circ$; $y = 20^\circ$
23. $x = 25^\circ$; $y = 40^\circ$

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 sides are proportional.
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.

6.7 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. 15
17. 14
19. 30
21. 2.8284
23. 4.8990
25. 5.8310
27. 28.2843
29. 15.5563
31. 0.5
33. 1.23
35. 1.4
37. 0.05
39. 0.0548

41. a. Answers will vary.

$$\sqrt{39} > \sqrt{36} = 6,$$

$$\text{so } \sqrt{39} > 6$$

b. Answers will vary.

$$\sqrt{39} < \sqrt{49} = 7,$$

$$\text{so } \sqrt{39} < 7$$

43. a. 7 and 8 b. 7.0711

45. a. 3 and 4 b. 3.3166

47. a. 7 and 8 b. 7.7460

49. Yes, $6^2 + 8^2 = 10^2$ 51. No, $3^2 + 4^2 \neq 6^2$ 53. Yes, $5^2 + 12^2 = 13^2$ 55. $c = 2.23$ 57. $c = 5$ 59. $c = 20.62$ 61. $c = 14.14 \text{ cm}$

Applications

63. 2.24 miles
65. 58.31 ft
67. 522.0 feet
69. a. 20 in. b. 25 in.²
c. 7.0711 in.
71. 64.9 inches
73. a. 17 feet b. 51 feet

Writing & Thinking

75. A perfect square is the result when a number is squared. For example 5 squared is 25, therefore 25 is the perfect square of 5. Then if one finds the square root of 25, the answer is 5 because the square root is the original number that was squared to get the result of 25.

77. 28.28 m

79.

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: Statistics, Graphs, and Probability

7.1 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 m³
b. 84,500 m³
c. None d. 82,700 m³
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

Applications

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.

7.2 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.

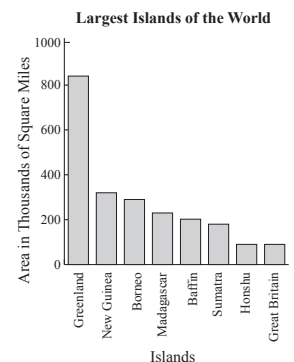
7.3 Exercises

Concept Check

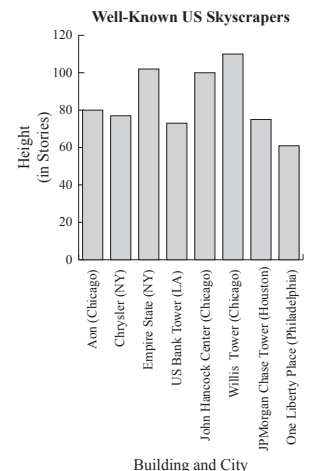
1. horizontal
3. width
5. 360
7. False; In creating a vertical bar graph, all bar widths should be the same.
9. True

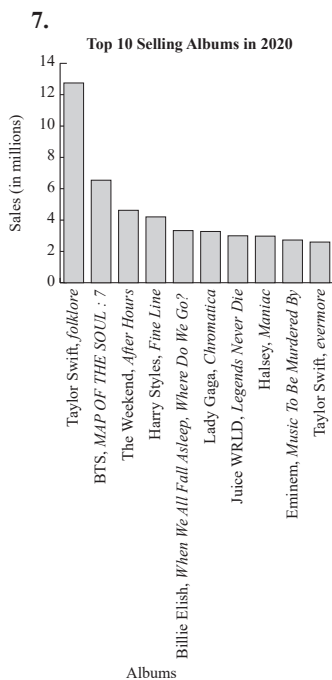
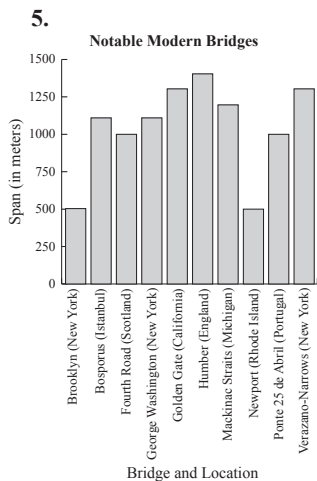
Applications

- 1.

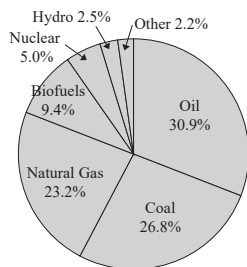


- 3.

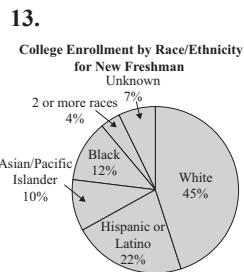
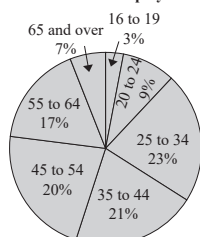




9. Global Share of Total Energy Supply by Source, 2019



11. 2021 Distribution of Employment by Age



Writing & Thinking

- 15.** Answers will vary. A person could mislabel or not label the graph at all. This mistake will make it difficult to properly interpret or understand the information presented. If the person does not pay attention to neatness and organization, the graph may be difficult to read. A person might forget to use appropriate titles which can decrease the understanding or purpose of the graph.

7.4 Exercises

Concept Check

- tree
- probability
- sample space
- False; The individual result of an experiment is an outcome.

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.**
-
- $S = \{HHHH, HHHT, HHHT, HHTT, HTHH, HTHT, HTTH, HTTT, THHH, THHT, THHT, THTT, TTHH, TTHT, TTTH, TTTT\}$

- $S = \{HHHH, HHHT, HHHT, HHTT, HTHH, HTHT, HTTH, HTTT, THHH, THHT, THHT, THTT, TTHH, TTHT, TTTH, TTTT\}$

- 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 six-sided 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 six-sided die.

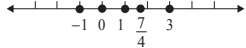
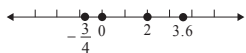
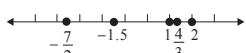
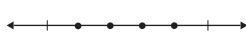
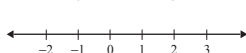
Chapter 8: Introduction to Algebra

8.1 Exercises

Concept Check

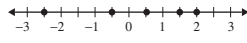
1. integers
3. irrational
5. graph
7. True
9. True

Practice

1. 3
3. 0
5. -2
7. 
9. 
11. 
13. 
15. 
17. 
19. 
21. 4, 8
23. -7, -2, 0, 4, 8
25. -7, -2, $-\frac{5}{3}$, -1.4, 0, $\frac{3}{5}$, 4, 5.9, 8
27. < 29. >
31. < 33. =
35. > 37. <
39. = 41. >
43. True
45. False; $-9 < -8.5$
47. True
49. True
51. False; $-|-3| > -|4|$
53. $x = -5, 5$
55. $x = -2, 2$
57. No solution
59. $x = -23, 23$
61. Sometimes. Examples will vary.

63. Always. Examples will vary.

Applications

65. -4500 meters
67. +8844 meters
69. a. $|x| \leq 3$
b. 
71. a. 
b. $-\frac{5}{2}$ has the furthest distance from zero.
73. a. $x = -5$ millimeters, 5 millimeters
b. The length of the board can be 5 mm longer or 5 mm shorter than 1 meter.
c. 1.05 m or 0.95 m
75. a. Fresno
b. El Centro

Writing & Thinking

77. If y is a negative number then $-y$ represents a positive number. For example, if $y = -2$, then $-y = -(-2) = 2$.

8.2 Exercises

Concept Check

1. positive
3. negative
5. equation
7. True

Practice

1. 13
3. -4
5. 0
7. 5
9. -13
11. -8
13. -10
15. 0
17. 17
19. -4.6

21. -29
23. -9
25. -15.4
27. -3
29. -54
31. -2.5
33. $\frac{3}{7}$
35. $\frac{5}{8}$
37. $-\frac{7}{4}$
39. -7
41. -0.5
43. 76
45. -310
47. 27
49. 2.3
51. 18
53. 14
55. 35
57. 84
59. 3807
61. -97,714

Applications

63. Profit: \$6000
65. a. -0.3 cm, -0.1 cm
b. 0.02 cm
c. Increase
67. 275 feet
69. 8 feet
71. 8
73. The solution is $-\$97.86$.

Writing & Thinking

75. $|0| + |0| = 0$
77. Sometimes. Examples will vary.
79. Sometimes. Examples will vary.
81. Never. Examples will vary.
83. Never. Examples will vary.

8.3 Exercises

Concept Check

1. additive inverse
3. left
5. subtract
7. False; The sum of a number and its additive inverse is zero.
9. True

Practice

1. -11
3. 6
5. -4.7
7. 0
9. $\frac{5}{7}$
11. 5
13. -10
15. 7
17. 3
19. 12
21. 24
23. 5.9
25. -4
27. 10
29. $-\frac{7}{20}$
31. $-\frac{1}{4}$
33. $\frac{3}{40}$
35. -15
37. -1
39. -3
41. 1
43. 0
45. $-8 < -5$
47. $-3.1 < 3.1$
49. $\frac{19}{4} = \frac{19}{4}$
51. $0 > -27$
53. $-237 > -248$
55. $1044 > -39$
57. $-15,254 > -35,090$
59. 1
61. -7
63. -26
65. 11

Applications

67. -18°F (a decrease of 18 degrees Fahrenheit)
69. \$7 (an increase of 7 dollars)
71. -14,787 ft (a decrease of 14,787 feet)
73. a. Negative b. Positive
c. May and June
d. Answer will vary. March and April or April and May

75. \$250,404
77. \$847
79. \$165
81. -6°C (or 6°C below 0°C)
83. 2316 points
85. 1220 gallons

87. a. 1454 people
b. 198,580 people
89. The solution is 90.85 g
91. 3 °F
93. 4238 points

Writing & Thinking

95. Add the opposite of the second number to the first number.
97. 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.

8.4 Exercises

Concept Check

- average, mean
- positive
- 0
- True
- False; The product and quotient will be positive.

Practice

- 12
- 48
- 56
- 21
- 56
- 26
- 70
- 24
- 288
- 0
- 9
- 7.31
- $-\frac{1}{6}$
- $\frac{18}{5}$
- $-\frac{12}{5}$
- $-\frac{9}{2}$
- 4
- 6
- 2
- 0
- 3
- 17
- Undefined
- 5
- 0.6
- 20
- 2.3
- $-\frac{1}{12}$
- $\frac{9}{22}$
- $-\frac{5}{12}$

- False; $(-4)(6) < 3 \cdot 8$
- True
- False;
 $6(-3) = (-14) + (-4)$
- True
- True
- 116,640
- 22,032
- 1682
- 45.5
- 9.5
- 54.605

Applications

- 12
- \$2975
- 8928 slices of bread
- \$442,800
- 3 cookies
- 22 teams
- 17 grams
- \$10,740 per year
- 1152 bags
- 427 sq ft
- 5423 dozen
- 2 slices
- 33,087.5 accidents
- a. -8 psi
b. -10.5 psi
c. 5.25 hours (or 5 hours 15 minutes)

- 26.6 calls
- 80
- 78.6 inches
- 31.5 hours
- 18,631.8 square miles

Writing & Thinking

- Positive; The product of two negative numbers will be positive so an even number of negatives will give a positive product.
- Answers will vary.

8.5 Exercises

Concept Check

- grouping symbols
- left, right
- 1

- True
- True

Practice

- a. 36 b. 16
- 25
- 45
- 137
- 152
- 189
- 143
- 36
- 10
- $\frac{11}{30}$
- $\frac{1}{24}$
- $\frac{31}{24}$
- $\frac{10}{3}$
- $\frac{41}{32}$
- $\frac{3}{5}$
- 5.7
- 3.5
- 24
- 5
- 1
- $-\frac{13}{64}$
- 42.45
- 67.77
- 15.41

Applications

- a. $\$11 \cdot \left(1\frac{1}{4}\right) + \$8.50$
b. \$22.25
c. \$31
- a. $-\$42 - \$35 - (3 \cdot \$5)$
b. -\$92
- a. $\left(12\frac{1}{2} + 15\frac{3}{4} + 11\frac{3}{4} - 1\frac{1}{4}\right) \div 6$
b. $6\frac{11}{24}$ pounds of potatoes
- a. $2 \cdot \$225 + 4 \cdot \$20 + 4 \cdot \$15$
b. \$147.50

Writing & Thinking

- Smaller; When any positive number is multiplied by a fraction (or decimal) between 0 and 1, the result will be smaller. This is what is happening when a number between 0 and 1 is squared. Answers will vary.

8.6 Exercises

Concept Check

- reciprocal
- zero factor
- opposite
- False; The commutative property of addition allows the order to change.
- False; The additive identity of all numbers is 0.

Practice

- $3 + 7$
- $4 \cdot 19$
- $30 + 48$
- $(2 \cdot 3) \cdot x$
- $(3 + x) + 7$
- 0
- $x + 7$
- $2x - 24$
- 0
- Commutative property of addition
- Multiplicative identity
- Associative property of addition
- Commutative property of multiplication
- Commutative property of multiplication
- Multiplicative inverse
- Additive inverse
- Multiplicative identity
- Zero-factor law
- Associative property of addition
- $6(11) = 66$ and $6 \cdot 3 + 6 \cdot 8 = 66$
- $10(-7) = -70$ and $10 \cdot 2 - 10 \cdot 9 = -70$
- Commutative property of multiplication; $6 \cdot 4 = 4 \cdot 6 = 24$
- Associative property of addition; $8 + (5 + (-2)) = (8 + 5) + (-2) = 11$
- 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

8.7 Exercises

Concept Check

- 1
- constant
- coefficients
- True
- False; In the term $12a$, 12 is the coefficient.

Practice

- -5 , 3, and 8 are like terms; $7x$ and $9x$ are like terms.
- $-x^2$ and $2x^2$ are like terms; $-6xy$ and $5xy$ are like terms; $3x^2y$ and $5x^2y$ are like terms.

5. 24, -6 , and 8.3 are like terms; $1.5xyz$, $-1.4xyz$, and xyz are like terms.
7. $15x$ 9. $3x$
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. $8x + y$ 37. $-2y$
39. $\frac{8x}{3}$ 41. -4
43. 4 45. -2

47. $3x + 4$; 13
49. $5y + 1$; 16
51. $-3.1a^2 + 4a$; -20.4
53. $3.7x + 1.1$; 15.9
55. $8a$; -16
57. $3b$; -3
59. $-x^2 + 5x - 7$; -21
61. $3y^2 - y$; 4
63. $4y^3 - 4y^2 + 5y + 1$; -12
65. $5x^2 + 9x - 22$; -20
67. $2a^2 - 2a$; 4
69. $9ab - 7a + 2b$; 21
71. $14a - 15b + 2c + 2$; 24
73. $10a + 10b + 10c$; 0

Applications

75. \$50,000
77. 375 pounds
79. a. $47s + 143m$
 b. 6170 boxes

Writing & Thinking

81. 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.

83. a. For $x = 3$,
 $4x^2 - 5(x + 2) + 3x + 10 + 2x$
 $= 4(3)^2 - 5(3 + 2) + 3(3) + 10 + 2(3)$
 $= 4(9) - 5(5) + 9 + 10 + 6$
 $= 36 - 25 + 9 + 10 + 6$
 $= 36$
- b.
 $4x^2 - 5(x + 2) + 3x + 10 + 2x$
 $= 4x^2 - 5x - 10 + 3x + 10 + 2x$
 $= 4x^2$
 For $x = 3$,
 $4x^2 = 4(3)^2$
 $= 4(9) = 36$
- The second method, as it requires fewer calculations.

8.8 Exercises

Concept Check

- ambiguous
- subtraction
- multiplication
- True
- 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.

Chapter 9: Solving Linear Equations and Inequalities

9.1 Exercises

Concept Check

- equation
- addition, equality
- dividing
- True
- True

Practice

- $x = -2$ is a solution
- $x = 4$ is not a solution
- $x = -4$ is a solution
- $x = -18$ is a solution
- $x = -28$ is a solution
- $x = 7$
- $y = -4$
- $x = -19$
- $n = 37$
- $z = -6$
- $x = 5$
- $y = -5.9$
- $x = -1.2$
- $x = \frac{11}{20}$
- $x = 9$
- $y = 8$
- $x = 20$
- $y = 10$
- $x = -8$
- $x = 12$
- $n = 8$
- $y = 2.1$
- $x = \frac{20}{9}$
- $x = -13.3$
- $y = -12$
- $x = -\frac{2}{5}$
- $x = -4$
- $x = \frac{5}{8}$
- $n = 9.7$
- $x = -4$

61. $y = -50.753$

63. $x = -17.214$

65. $x = 246$

67. $x = -153.17$

Applications

- 1945 *kanji* characters
- a. Answers will vary.
b. $x = 12.5$
c. The garden should be 12.5 feet wide.
- 4.24 light years
- 11,500 words
- 2250 students
- a. Answers will vary.
b. $x = 11,550$
c. Clara will need a loan for \$11,550.

Writing & Thinking

- 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.

9.2 Exercises

Concept Check

- like
- multiplication
- substituting
- False; Subtract 3 from both sides.
- True

Practice

- $x = -3$
- $x = 2$
- $x = 2$
- $x = 2$
- $y = -1$
- $t = -1$
- $x = -0.12$
- $x = 4$
- $x = 0$

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

- 14,000 tickets per hour
- 52 pages
- 240 cookies of each remaining variety
- 135 yards
- 379.7 feet
- a. Lowest temperature; Change in temperature per hour; Current temperature
b. $x = 4$
c. The low temperature occurred 4 hours ago.

Writing & Thinking

- 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 $x = 15$.

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

9.3 Exercises

Concept Check

- identity
- conditional
- real, $\mathbb{R}$
- True
- True

Practice

- $x = -5$
- $n = 3$
- $y = 6$
- $x = 3$
- $n = 0$
- $y = 0$
- $z = -1$
- $y = \frac{1}{5}$
- $x = -3$
- $x = -4$
- $x = -21$
- $y = 0$
- $y = 1$
- $x = -\frac{3}{2}$
- $x = \frac{1}{4}$
- $x = \frac{3}{17}$
- $x = -\frac{1}{4}$
- $x = \frac{8}{5}$

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.

9.4 Exercises

Concept Check

- mathematically
- time
- substitute
- False; Case matters in formulas.
- True

Applications

- \$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. $\beta = 180^\circ - \alpha - \gamma$

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. 1.5
 d. -12

9.5 Exercises

Concept Check

- consecutive
- $n + 2, n + 4$
- 2
- True
- 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; $n = 3$

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

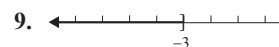
b. 26 million

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

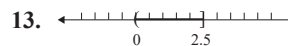
59. He would not be able to paddle faster than the current, so he would not be able to return upriver at all; Correct answer: $\frac{2}{3}$ mph



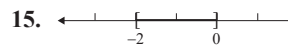
Half-open interval



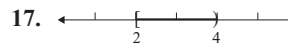
Open interval



Half-open interval

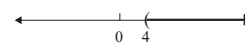


Closed interval

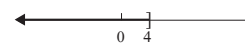


Half-open interval

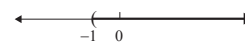
19. $(4, \infty)$



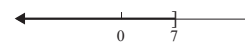
21. $(-\infty, 4]$



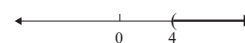
23. $(-1, \infty)$



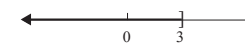
25. $(-\infty, 7]$



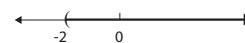
27. $(4, \infty)$



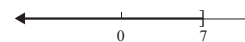
29. $(-\infty, 3]$



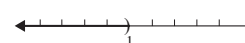
31. $(-2, \infty)$



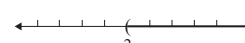
33. $(-\infty, 7]$



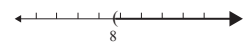
35. $(-\infty, 1)$



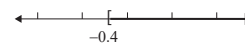
37. $(2, \infty)$



39. $(\frac{8}{3}, \infty)$



41. $[-0.4, \infty)$



9.6 Exercises

Concept Check

- rate, time
- 12%
- one
- False; The value of r should be written as a decimal number.
- True

Applications

- a. Original price
b. x ; $0.20x$ c. \$119.95
- a. 2 liters b. $0.25x$
c. $x + 20$
d. $0.20(x + 20) = 2 + 0.25x$
e. 40 liters
- 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.
- 1.68 mph
- 8.75 hours
- 3 hours
- 50 mph; 300 miles

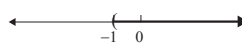
9.7 Exercises

Concept Check

- interval
- closed
- addition
- True
- False; Only one value in the solution set needs to be checked.

Practice

1. $(-1, \infty)$



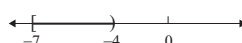
3. $(-\infty, 5]$

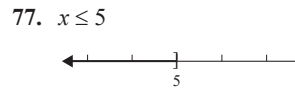
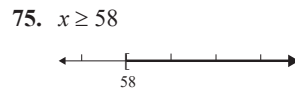
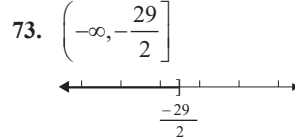
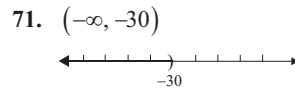
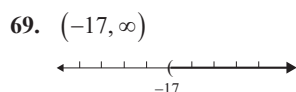
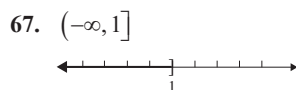
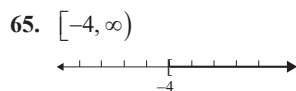
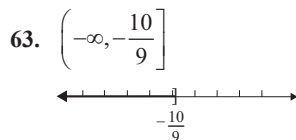
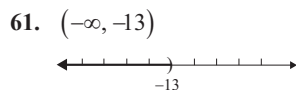
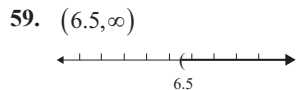
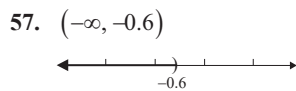
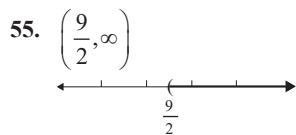
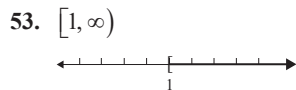
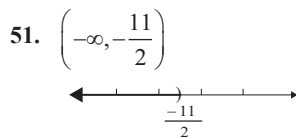
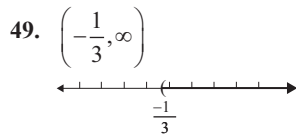
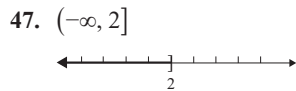
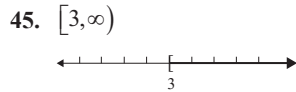
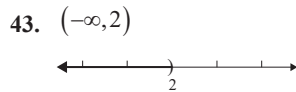


5. $[-5, -1]$



7. $[-7, -4)$





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.

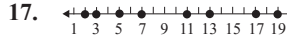
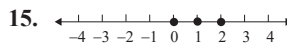
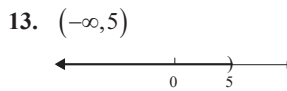
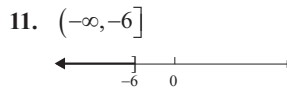
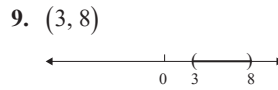
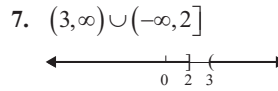
9.8 Exercises

Concept Check

- elements
- such that
- roster
- False; The union of two sets contains elements that belong to either one set, the other set, or both sets.
- True

Practice

- Union: $\{1, 2, 3, 4, 6, 8\}$;
Intersection: $\{2, 4\}$
- Union: $\{-4, -3, -2, -1, 0, 1, 2, 4, 6\}$;
Intersection: $\{0\}$
- Union: $\{1, 2, 4, 8, 16, 32, 64\}$;
Intersection: $\{1, 4, 16\}$



19. $\{x | 3 \leq x < 5\}$

21. $\{x | x \geq -2.5\}$

23. a. $\{x | -3 \leq x \leq 1\}$

b. $[-3, 1]$

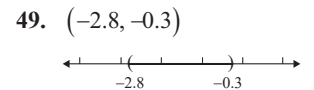
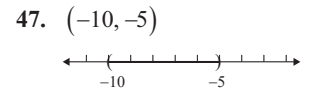
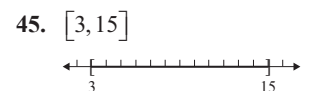
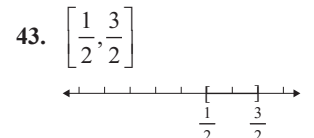
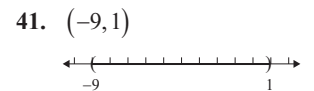
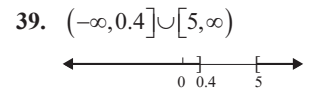
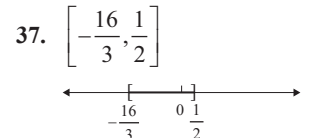
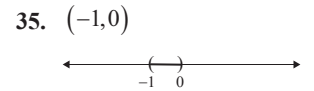
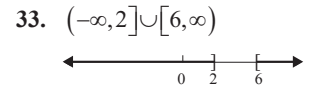
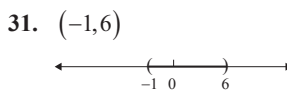
25. a. $\{x | -8 < x \leq -2\}$

b. $(-8, -2]$

27. a. $\{x | x \leq 1\}$ b. $(-\infty, 1]$

29. a. $\{x | -4 < x < 4\}$

b. $(-4, 4)$



Writing & Thinking

51. Answers will vary. Answers should mention that *and* indicates the intersection and *or* indicates the union.

9.9 Exercises

Concept Check

- standard
- distance
- False; Equations involving absolute value can have more than one solution.
- True

Practice

- $x = -8, 8$
- No solution
- $x = -5, -1$

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. $x = -20, \frac{40}{9}$

9.10 Exercises

Concept Check

1. standard

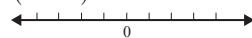
3. or

5. False; Only one statement/inequality must be true.

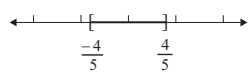
7. False; Must be greater than 2

Practice

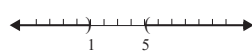
1. $(-\infty, \infty)$



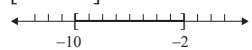
3. $\left[-\frac{4}{5}, \frac{4}{5}\right]$



5. $(-\infty, 1) \cup (5, \infty)$



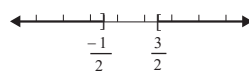
7. $[-10, -2]$



9. $(-\infty, -8] \cup [-2, \infty)$

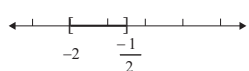


11. $\left(-\infty, -\frac{1}{2}\right] \cup \left[\frac{3}{2}, \infty\right)$

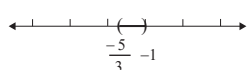


13. No solution

15. $\left[-2, -\frac{1}{2}\right]$



17. $\left(-\frac{5}{3}, -1\right)$



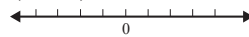
19. $\left(-\infty, -\frac{2}{3}\right] \cup [6, \infty)$



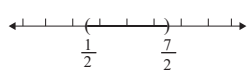
21. $[-1, 10]$



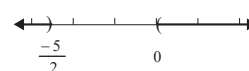
23. $(-\infty, \infty)$



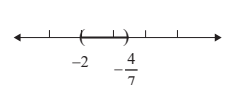
25. $\left(\frac{1}{2}, \frac{7}{2}\right)$



27. $\left(-\infty, -\frac{5}{2}\right) \cup (0, \infty)$



29. $\left(-2, -\frac{4}{7}\right)$



Writing & Thinking

31. a.



b. $|x| \leq 10$

c. $[-10, 10]$

Closed interval

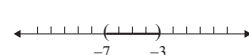
33. a.



b. $|x - 8| > 6$

c. $(-\infty, 2) \cup (14, \infty)$

35. a.



b. $|x + 5| < 2$

c. $(-7, -3)$, Open interval

Chapter 10: Graphing Linear Equations and Inequalities

10.1 Exercises

Concept Check

1. quadrants

3. III

5. origin

7. True

9. True

Practice

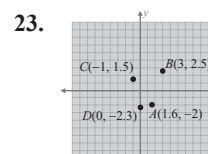
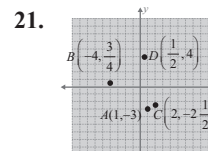
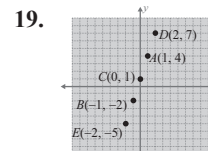
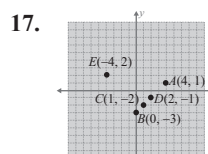
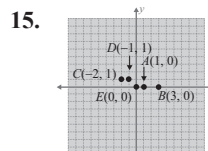
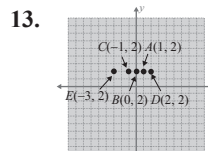
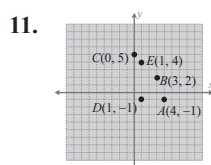
1. $\left\{ \begin{array}{l} A(-5, 1), B(-3, 3), \\ C(-1, 1), D(1, 2), \\ E(2, -2) \end{array} \right\}$

3. $\left\{ \begin{array}{l} A(-3, -2), \\ B(-1, -3), C(-1, 3), \\ D(0, 0), E(2, 1) \end{array} \right\}$

5. $\left\{ \begin{array}{l} A(-4, 4), B(-3, -4), \\ C(0, -4), D(0, 3), \\ E(4, 1) \end{array} \right\}$

7. $\left\{ \begin{array}{l} A(-3, -5), B(-1, 4), \\ C(0, -1), D(3, 1), \\ E(6, 0) \end{array} \right\}$

9. $\left\{ \begin{array}{l} A(-5, 0), B(-2, 2), \\ C(-1, -4), D(0, 6), \\ E(2, 0) \end{array} \right\}$



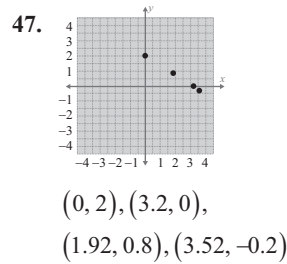
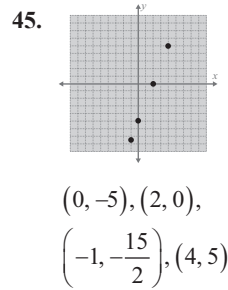
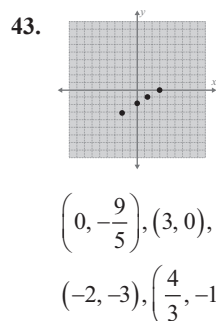
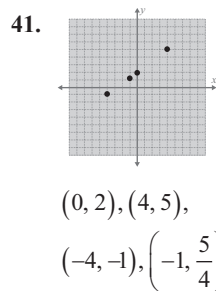
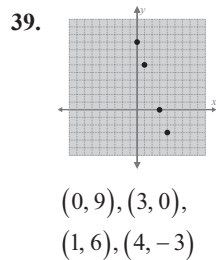
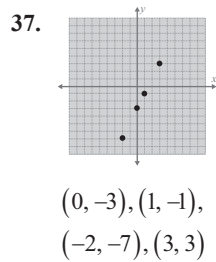
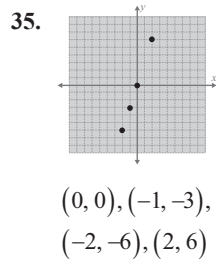
25. $(0, -4), (2, -2), (4, 0), (1, -3)$

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. $\left(0, -\frac{7}{4}\right), (1, -1), \left(\frac{7}{3}, 0\right), \left(3, \frac{1}{2}\right)$

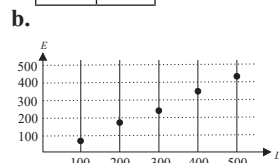


49. b, c, d
 51. a, d
 53. a, c, d
 55. For example, $(-3, -3), (0, 1)$, and $(3, 5)$.
 57. For example, $(-3, -1), (0, 0)$, and $(3, 1)$.
 59. For example, $(-2, 3), (0, 3)$, and $(4, 3)$.
 61. For example, $(-4, -4), (0, -3)$, and $(4, -2)$.
 63. For example, $(-3, -3), (-2, 0)$, and $(-1, 3)$.

Applications

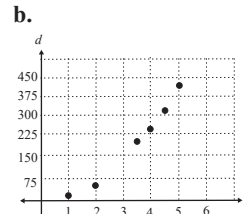
65. a.

D	E
100	85
200	170
300	255
400	340
500	425

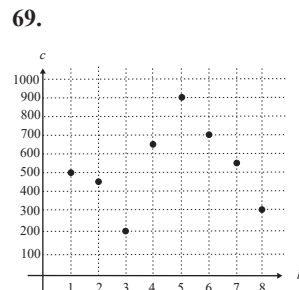


67. a.

t	d
1	16
2	64
3.5	196
4	256
4.5	324
5	400

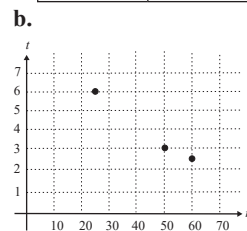


c. The time t is squared in the equation.



71. a.

r (mph)	t (hours)
25	6
50	3
60	2.5



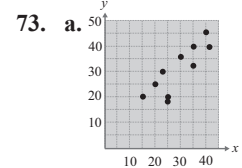
c. The time decreases as the rate increases.

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



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.

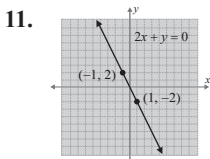
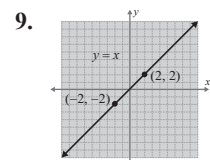
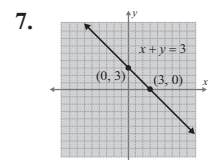
10.2 Exercises

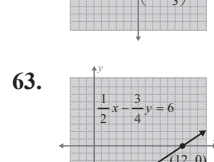
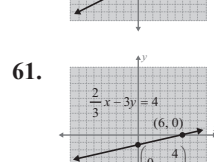
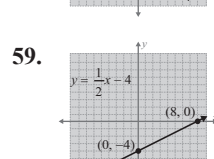
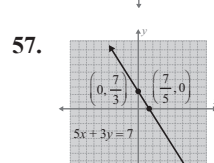
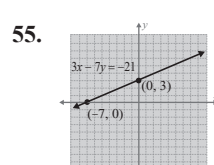
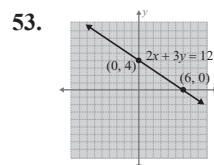
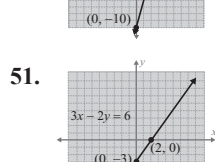
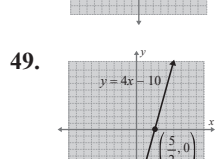
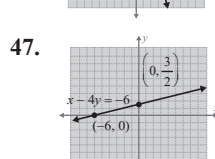
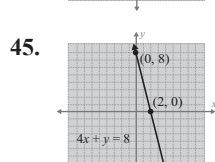
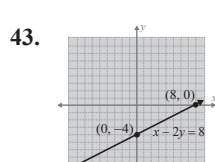
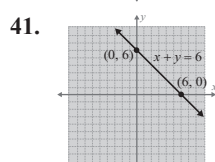
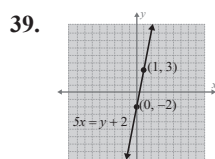
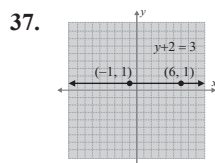
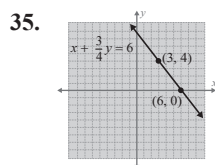
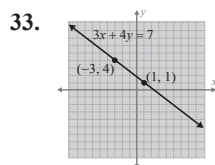
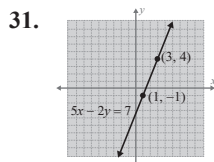
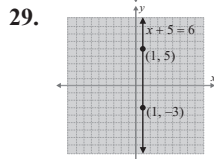
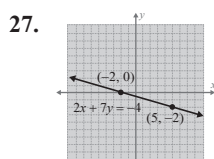
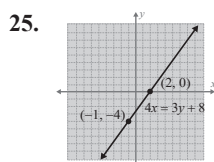
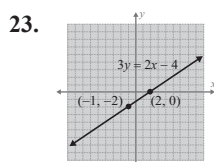
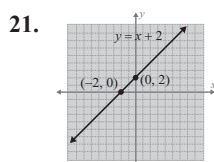
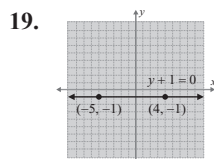
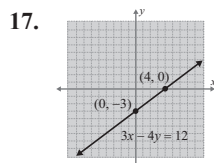
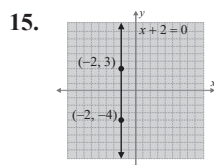
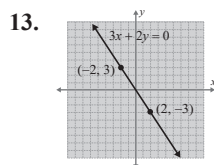
Concept Check

- y
- infinite
- line
- True
- False; Horizontal lines have y -intercepts.

Practice

- a.
- d.
- f.



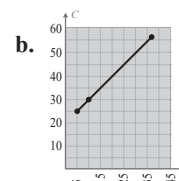


c. Answers will vary.
Negative number of cookies; Total amount of cookies is over 30 dozen.

d. 14 dozen chocolate chip cookies

69. a.

n	5	10	37
C	25	30	57



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.

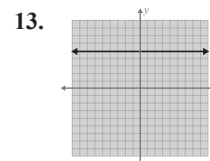
10.3 Exercises

Concept Check

- run
- positive
- 0
- True
- True

Practice

- $m = 5$
- $m = -\frac{1}{7}$
- $m = 0$
- $m = \frac{1}{2}$
- $m = 2$
- $m = \frac{1}{5}$

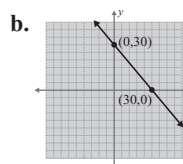


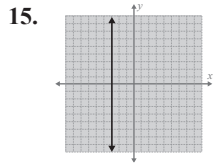
Horizontal line; $m = 0$

Applications

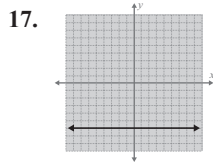
65. The x -intercept is $(12, 0)$ meaning that after 12 days, there will be 0 mg of potassium remaining in the bottle of sports drink. The y -intercept is $(0, 360)$ meaning that the original amount of potassium in the sports drink is 360 mg.

67. a. C -intercept: $(30, 0)$
 P -intercept: $(0, 30)$

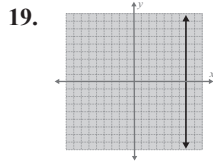




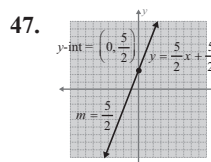
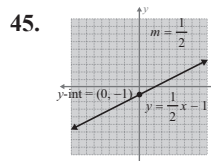
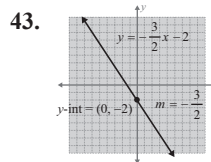
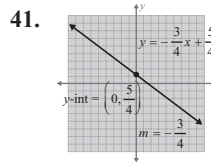
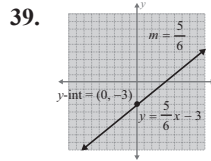
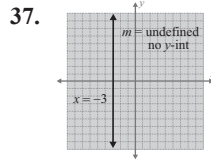
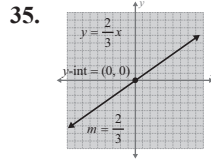
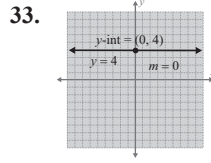
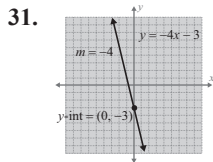
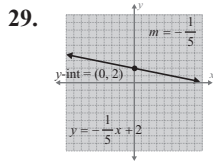
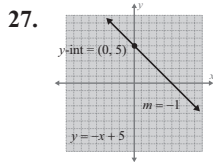
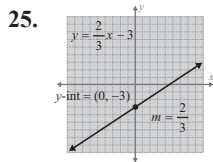
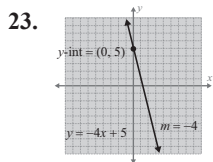
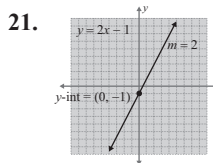
Vertical line;
 m is undefined



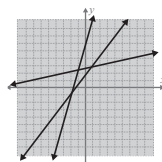
Horizontal line; $m = 0$



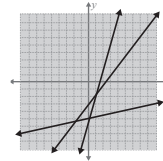
Vertical line;
 m is undefined



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

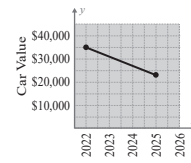
Applications

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

79. $\frac{11}{10}$

81. 54 mph

83. \$4000/year

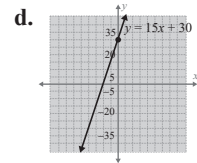


85. -5.66

87. a. Slope is \$15; Units are dollars and paintings

b. $(0, 30)$

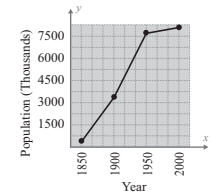
c. $y = 15x + 30$



e. Answers will vary.
 x cannot be negative since you can't sell a negative number of paintings.

f. \$90

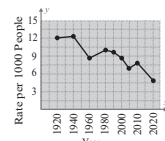
89. a. and b.



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

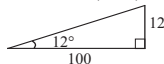
d. # of marriages decreased 0.18 marriages/1000 people from '40-'60, increased 0.075 marriages/1000 people from '60-'80, decreased 0.02 marriages/1000 people from '80-'90, decreased 0.13 marriages/1000 people from '90-'00, decreased 0.14 marriages/1000 people from '00-'10,

and decreased 0.17 marriages/1000 people per year from '10-'20.

Writing & Thinking

93. a. The x -axisb. 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.



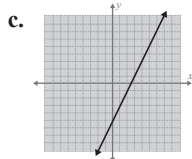
10.4 Exercises

Concept Check

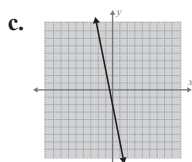
1. negative reciprocals
3. same
5. slope
7. True
9. True

Practice

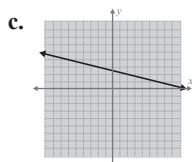
1. a.
- $m = 2$
- b.
- $(3, 1)$



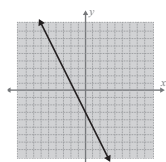
3. a.
- $m = -5$
- b.
- $(0, -2)$



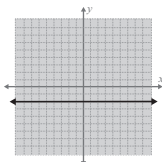
5. a.
- $m = -\frac{1}{4}$
- b.
- $(-2, 3)$



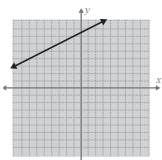
- 7.
- $2x + y = -3$



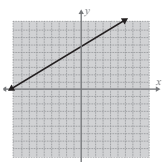
- 9.
- $y = -2$



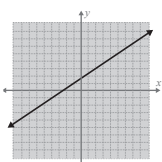
- 11.
- $x - 2y = -15$



- 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.
- $3x - 4y = -14$

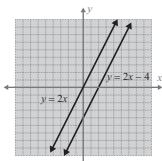
- 33.
- $7x + 3y = -5$

- 35.
- $y = 6$

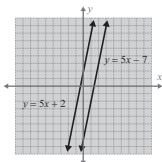
- 37.
- $y = 7$

- 39.
- $y = 7$

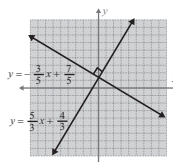
- 41.
- $y = 2x$



- 43.
- $y = 5x + 2$

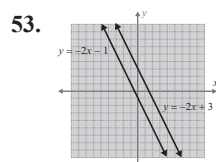
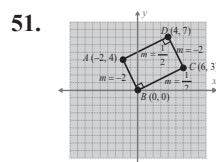


- 45.
- $y = -\frac{3}{5}x + \frac{7}{5}$

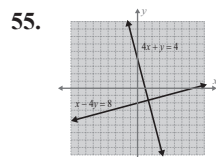


- 47.
- $y = -\frac{1}{3}x$

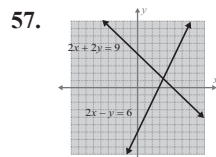
- 49.
- $y = -\frac{1}{2}x - 2$



Parallel



Perpendicular

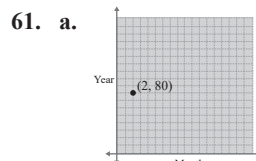


Neither

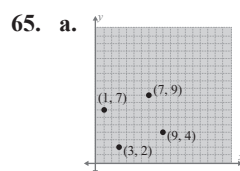
Applications

59. a.
- $P = 100t - 5000$

b. 50 tickets

b. $y - 80 = 10(x - 2)$

63. a.
- $f = 5 + 2m$
- b. \$35



- 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

10.5 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.
- $\{(-4, -3), (-4, 1), (-1, -1), (-1, 3), (3, -4)\}$
- ;

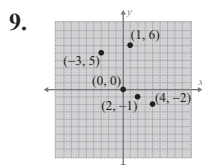
 $D = \{-4, -1, 3\}$; $R = \{-4, -3, -1, 1, 3\}$;

Not a function

- 7.
- $\{(-5, -5), (-5, 3), (0, 5), (1, -2), (1, 2)\}$
- ;

 $D = \{-5, 0, 1\}$; $R = \{-5, -2, 2, 3, 5\}$;

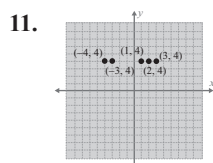
Not a function



$$D = \{-3, 0, 1, 2, 4\};$$

$$R = \{-2, -1, 0, 5, 6\};$$

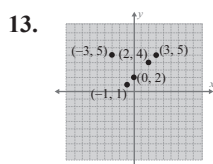
Function



$$D = \{-4, -3, -2, -1, 0, 1, 2, 3, 4\};$$

$$R = \{4\};$$

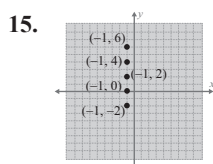
Function



$$D = \{-3, -2, -1, 0, 1, 2, 3\};$$

$$R = \{1, 2, 4, 5\};$$

Function



$$D = \{-1\};$$

$$R = \{-2, 0, 2, 4, 6\};$$

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. $\left\{ (-2, -11), (-1, -2), (0, 1), (1, -2), (2, -11) \right\}$

33. $D = (-\infty, \infty)$

35. $D = (-\infty, 0) \cup (0, \infty)$
or $x \neq 0$

37. $D = (-\infty, 3) \cup (3, \infty)$
or $x \neq 3$

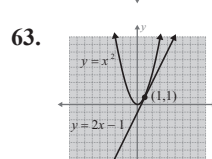
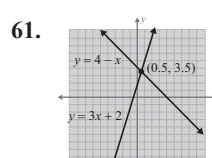
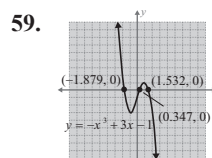
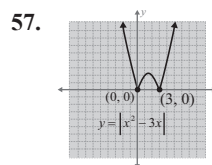
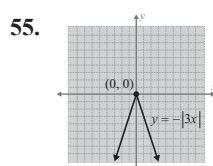
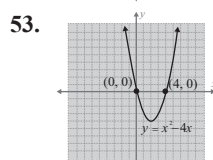
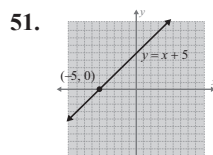
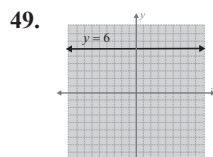
39. a. -4 b. -16 c. -10

41. a. 0 b. 12 c. 56

43. a. -3 b. 0 c. 3

45. $f(1) = 3$

47. $f(4) = 0$



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.

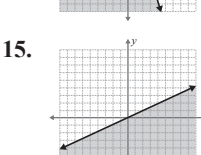
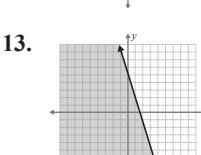
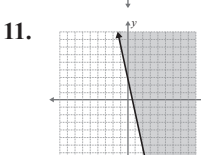
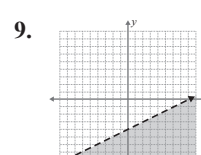
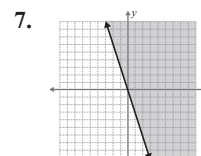
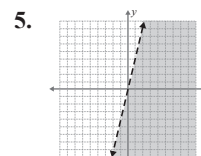
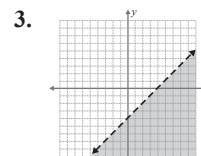
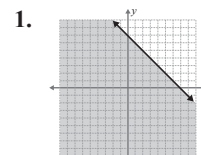
g. \$1000

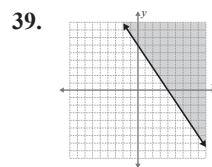
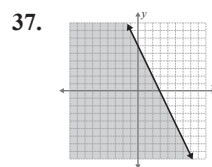
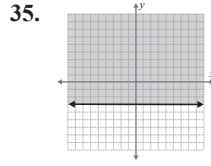
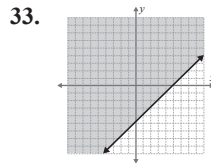
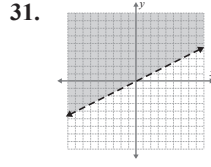
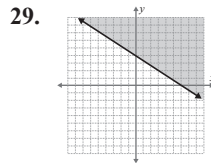
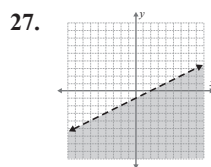
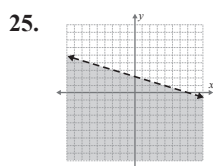
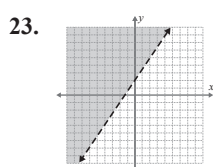
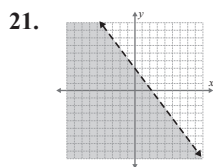
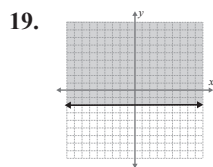
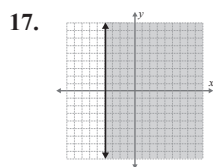
10.6 Exercises

Concept Check

- test
- open
- closed
- True
- False; The boundary line is solid if the inequality uses $\leq$ or $\geq$.

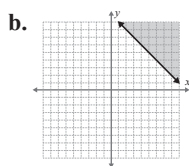
Practice





Applications

41. a. $x + y \geq 75$



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 11: Systems of Linear Equations

11.1 Exercises

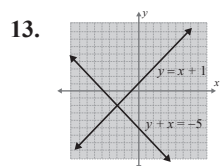
Concept Check

- simultaneous
- same
- one
- False; The solution must be checked in all equations.
- True

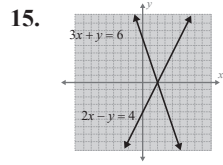
Practice

- c
- a, c
- (0, 2)
- (4, 2)
- $m_1 = -2, b_1 = 3,$
 $m_2 = -2, b_2 = \frac{5}{2}$

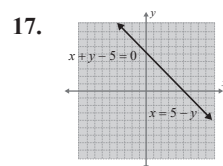
11. $m_1 = \frac{1}{2}, b_1 = 3,$
 $m_2 = \frac{1}{2}, b_2 = -\frac{1}{2}$



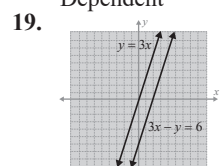
$(-3, -2)$; Consistent;
Independent



$(2, 0)$; Consistent;
Independent

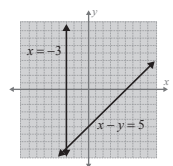


$(x, -x + 5)$; Consistent;
Dependent

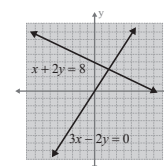


No solution; Inconsistent;
Independent

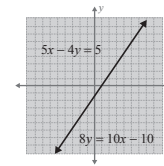
21. $(-3, -8)$



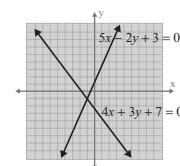
23. $(2, 3)$



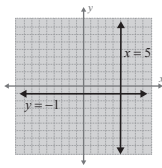
25. $\left(x, \frac{5}{4}x - \frac{5}{4}\right)$



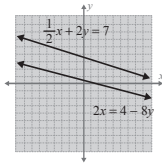
27. $(-1, -1)$



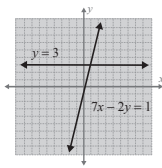
29. $(5, -1)$



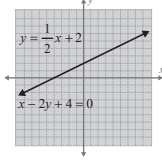
31. No solution



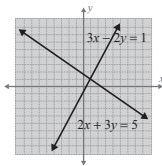
33. $(1, 3)$



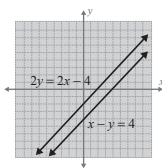
35. $(x, \frac{1}{2}x + 2)$



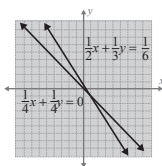
37. $(1, 1)$



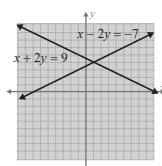
39. No solution



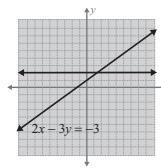
41. $(1, -1)$



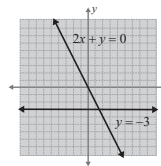
43. $(1, 4)$



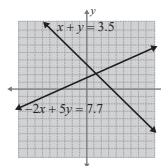
45. $(1.5, 2)$



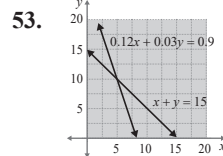
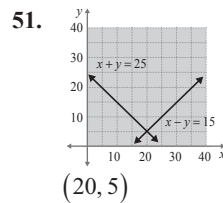
47. $(1.5, -3)$



49. $(1.4, 2.1)$



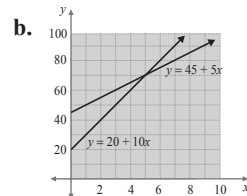
Applications



5 gallons of 12%;
10 gallons of 3%

55. 134 hours

57. a. Fit4life: $y = 20 + 10x$;
Workout Nation:
 $y = 45 + 5x$



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.

11.2 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. $(2, \frac{5}{2})$
19. $(\frac{1}{2}, -4)$
21. $(\frac{7}{2}, -\frac{1}{2})$
23. $(x, 2 - 3x)$
25. $(-2, 1)$
27. $(-\frac{4}{5}, -\frac{7}{5})$
29. $(\frac{11}{7}, \frac{8}{7})$
31. $(x, \frac{1}{6}x + \frac{10}{3})$
33. $(3, 3)$
35. $(10, 20)$
37. No solution
39. $(x, -\frac{3}{2}x + 12)$
41. $(2, \frac{5}{3})$

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.

11.3 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. $(1, -\frac{3}{2})$
5. No solution
7. $(x, 3 - x)$
9. $(-2, -3)$
11. $(7, 5)$
13. $(1, -5)$
15. $(x, \frac{1}{2}x - 2)$
17. $(\frac{22}{7}, -\frac{2}{7})$
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.

11.4 Exercises

Practice

1. 23, 33
 3. 15, 21
 5. 37, 50

Applications

7. $80^\circ, 100^\circ$
 9. $55^\circ, 55^\circ, 70^\circ$
 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 $\times$ 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.

11.5 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.

11.6 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. $\left(\frac{1}{2}, \frac{1}{3}, -1\right)$

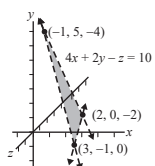
Applications

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. $A = 4$, $B = 2$, $C = -1$



11.7 Exercises

Concept Check

- matrix, matrices
- dimension
- augmented
- False; A matrix that has 3 rows and 5 columns is a 3×5 matrix.
- False; Interchanging two equations in a system of linear equations will not change the solution.

Practice

- $\begin{bmatrix} 2 & 2 \\ 5 & -1 \end{bmatrix}, \begin{bmatrix} 2 & 2 & 13 \\ 5 & -1 & 10 \end{bmatrix}$
- $\begin{bmatrix} 7 & -2 & 7 \\ -5 & 3 & 0 \\ 0 & 4 & 11 \end{bmatrix}, \begin{bmatrix} 7 & -2 & 7 & 2 \\ -5 & 3 & 0 & 2 \\ 0 & 4 & 11 & 8 \end{bmatrix}$

Applications

41. 52, 40, 77
 43. Bacon: \$3.09/lb;
 Eggs: \$4.03/doz;
 Bread: \$1.40/loaf

$$5. \begin{bmatrix} 3 & 1 & -1 & 2 \\ 1 & -1 & 2 & -1 \\ 0 & 2 & 5 & 1 \\ 1 & 3 & 0 & 3 \end{bmatrix}, \begin{bmatrix} 3 & 1 & -1 & 2 & 6 \\ 1 & -1 & 2 & -1 & -8 \\ 0 & 2 & 5 & 1 & 2 \\ 1 & 3 & 0 & 3 & 14 \end{bmatrix}$$

$$7. \begin{cases} -3x + 5y = 1 \\ -x + 3y = 2 \end{cases}$$

$$9. \begin{cases} x + 3y + 4z = 1 \\ 2x - 3y - 2z = 0 \\ x + y = -4 \end{cases}$$

$$11. a. \begin{bmatrix} -1 & 7 \\ 1 & 4 \end{bmatrix}$$

$$b. \begin{bmatrix} 1 & 4 \\ 2 & -14 \end{bmatrix}$$

$$13. a. \begin{bmatrix} 1 & 3 & 7 \\ 4 & -1 & 6 \\ -8 & -2 & 5 \end{bmatrix}$$

$$b. \begin{bmatrix} 1 & 3 & 7 \\ -16 & 0 & -7 \\ 4 & -1 & 6 \end{bmatrix}$$

$$15. (-1, 2)$$

$$17. (-1, -1)$$

$$19. (-1, -2, 3)$$

$$21. (1, 0, 1)$$

$$23. (2, 1, -1)$$

$$25. (-2, 9, 1)$$

$$27. \text{No solution}$$

$$29. \text{Infinite number of solutions}$$

$$31. (1, -3, 2)$$

$$33. (0, -4)$$

$$35. (2, 1, 7)$$

$$37. (2, -3, 4)$$

$$39. \left(\frac{13}{12}, \frac{5}{4}, \frac{8}{3} \right)$$

$$45. a. \begin{cases} u + c = 12 \\ 2500u + 625c = 13,125 \end{cases}$$

$$b. \begin{bmatrix} 1 & 1 & 12 \\ 2500 & 625 & 13,125 \end{bmatrix}$$

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.

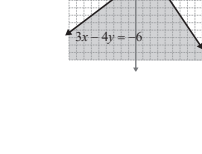
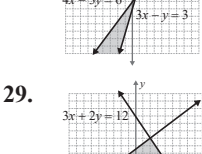
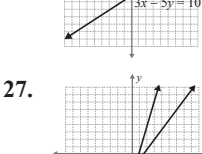
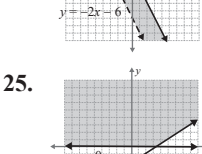
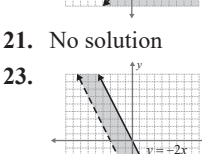
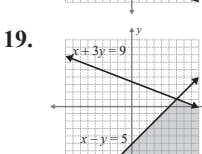
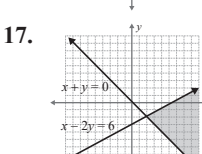
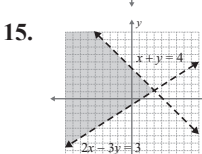
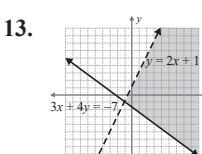
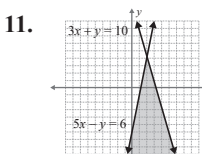
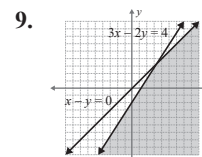
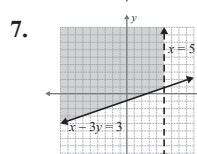
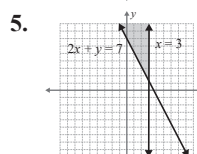
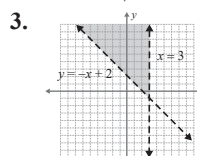
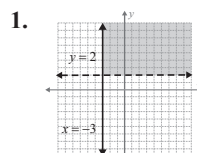
11.8 Exercises

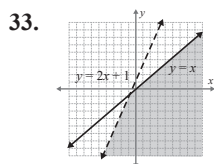
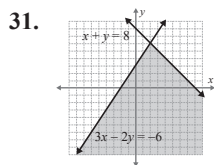
Concept Check

- test-point
- closed
- three
- 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

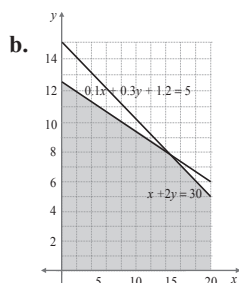
Practice





Applications

35. a.
$$\begin{cases} 0.1x + 0.3y + 1.2 < 5 \\ x + 2y < 30 \end{cases}$$

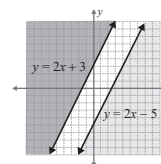


c. Answers will vary.

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 12: Exponents and Polynomials

12.1 Exercises

Concept Check

- subtract
- positive
- a
- False; If there is no exponent written, the exponent is assumed to be 1.
- True

Practice

- 27
- 512
- $\frac{1}{3}$
- $\frac{1}{25}$
- 16
- 24
- 500
- $\frac{3}{8}$
- $-\frac{3}{25}$
- x^5
- y^2
- $\frac{1}{x^3}$
- $\frac{2}{x}$
- $-\frac{8}{y^2}$
- $\frac{5x^6}{y^4}$
- 4
- 49
- $\frac{1}{10}$
- $\frac{1}{8}$
- x^2
- x^2
- x^4
- $\frac{1}{x^4}$
- x^6
- x^2
- y^2
- $3x^3$
- x^4
- $36x^3$
- $-14x^5$

- $-12x^6$
- $4y$
- $3y^2$
- $-2y^2$
- $\frac{1}{x^2}$
- 1000
- 1
- $-18x^5y^7$
- $-\frac{2y^2}{x}$
- $12a^3b^9c$
- $-4a^{10}b^3c$
- $\frac{5}{x}$
- 1
- 0.3906
- 8875.147264

Applications

- 2^8 GB
- 10^{-24} cm³
- 1 delivery
- 3^9 square yards
- a. $(2x)^3$
b. Product rule for exponents
c. $8x^3$ d. 64 cm³
- a. $\frac{2^{38}}{230} = 28$ gigabytes
b. 256 gigabytes
c. Quotient rule

12.2 Exercises

Concept Check

- exponent(s)

- multiply, keep
- coefficient
- True
- True

Practice

- 81
- 16
- 1,000,000
- a^6
- $\frac{1}{x^{10}}$
- $\frac{1}{256}$
- $9y^2$
- $16x^2y^2$
- $\frac{1}{x^6y^6}$
- $36x^6$
- $-108x^6$
- $\frac{5x^2}{y}$
- $-\frac{2y^6}{27x^{15}}$
- $\frac{a^4}{b^4}$
- $\frac{4}{9}$
- $\frac{x^6}{y^6}$
- $\frac{27x^3}{y^3}$
- 1
- $4x^4y^4$
- $\frac{y^2}{x^2}$
- $\frac{1}{3xy^2}$
- $-\frac{x^3y^6}{27}$
- m^2n^4
- $-\frac{y^2}{49x^2}$
- $\frac{25x^6}{y^2}$
- $\frac{x^6}{y^6}$
- $\frac{36y^{14}}{x^4}$
- $\frac{49y^4}{x^6}$
- $\frac{24y^5}{x^7}$
- $\frac{4x^3}{3}$
- $\frac{16x^{13}}{243y^6}$

12.3 Exercises

Concept Check

- 1, 10
- decimal point
- False; The decimal point should be moved 3 places to the left.
- False; 4000 written in scientific notation is 4.0×10^3 .

Practice

- 8.6×10^4
- 3.62×10^{-2}
- 1.83×10^7
- 2.368×10^{-10}
- 9×10^{-7}
- 3.28×10^{-11}
- 0.042
- 7,560,000
- 0.00006132
- 30,670,000,000
- 7,205,000,000
- 0.00000691
- $(3 \times 10^2)(1.5 \times 10^{-4})$;
 4.5×10^{-2}

27. $(3 \times 10^{-4})(2.5 \times 10^{-6})$;
 7.5×10^{-10}

29. $(2.34 \times 10^{10})(5.5 \times 10^9)$;
 1.287×10^{20}

31. $\frac{3.9 \times 10^3}{3 \times 10^{-3}}$; 1.3×10^6

33. $\frac{1.25 \times 10^2}{5 \times 10^4}$; 2.5×10^{-3}

35. $\frac{1.3 \times 10^{-12}}{2.6 \times 10^{-8}}$; 5×10^{-5}

37. $\frac{(8.4 \times 10^{-3})(3 \times 10^{-3})}{(2.1 \times 10^{-1})(6 \times 10)};$
 2×10^{-6}

39. $\frac{(5.4 \times 10^0)(3 \times 10^{-3})(5 \times 10)}{(1.5 \times 10)(2.7 \times 10^{-3})(2 \times 10^2)};$
 1×10^{-1}

41. $\frac{(1.4 \times 10^{-2})(9.22 \times 10^2)}{(3.5 \times 10^3)(2.0 \times 10^6)};$
 1.844×10^{-9}

43. $\frac{(2.5 \times 10)(3.75 \times 10^{-5})}{(4 \times 10^{10})(7.5 \times 10^{-6})};$
 3.125×10^{-9}

45. $\frac{(1.4 \times 10^{-7})(7 \times 10^{13})}{4 \times 10};$
 2.45×10^5

47. $\frac{(1.95 \times 10^{-5})(2.65 \times 10^3)(7.56 \times 10^{10})}{(1.5 \times 10^7)(1.3 \times 10^{-13})};$
 2.0034×10^{15}

49. 3_{E8}

51. 8.5_{E7}

53. 3_{E22}

55. 1.6051_{E15}

57. 1_{E2}

59. 1.02_{E22}

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. 2.592×10^6 seconds

73. No. Should be 5.2×10^5

12.4 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. $3a + 11$

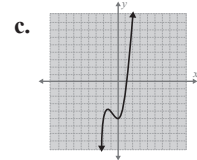
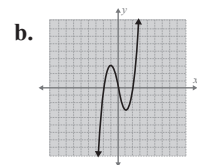
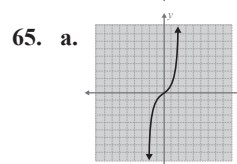
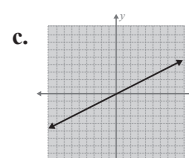
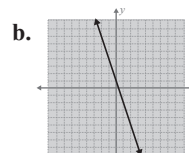
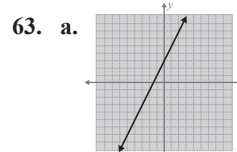
47. $10a + 25$

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.



12.5 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

67. a. $27x - 40$ dollars

b. \$284

Writing & Thinking

69. Add the opposite of each term in the polynomial being subtracted to the original polynomial and combine like terms.

12.6 Exercises

Concept Check

- distributive
- FOIL
- like
- False; The product of $(a + b)$ and $(c + d)$ is $ac + ad + bc + bd$.

Practice

- $-6x^5 - 15x^3$
- $4x^7 - 12x^6 + 4x^5$
- $-y^5 + 8y - 2$
- $-4x^8 + 8x^7 - 12x^4$
- $25x^5 - 5x^4 + 10x^3$
- $a^7 + 2a^6 - 5a^3 + a^2$
- $x^2 + x - 12$
- $a^2 - 2a - 48$
- $x^2 - 3x + 2$

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

- a. Answers will vary.
- b. Answers will vary.

12.7 Exercises

Concept Check

- difference
- trinomial
- False; The product will be a binomial.
- True

Practice

- $x^2 - 14x + 49$;
Perfect square trinomial
- $x^2 + 8x + 16$;
Perfect square trinomial
- $x^2 - 9$;
Difference of two squares
- $x^2 - 81$;
Difference of two squares
- $2x^2 + x - 3$
- $9x^2 - 24x + 16$;
Perfect square trinomial
- $25x^2 - 4$;
Difference of two squares
- $9x^2 - 12x + 4$;
Perfect square trinomial
- $x^2 - 16x + 64$;
Perfect square trinomial
- $16x^2 - 25$;
Difference of two squares
- $25x^2 - 81$;
Difference of two squares
- $x^2 - 8x + 16$;
Perfect square trinomial
- $4x^2 - 49$;
Difference of two squares
- $10x^4 - 11x^2 - 6$
- $49x^2 + 14x + 1$;
Perfect square trinomial
- $x^2 + 10x + 25$
- $x^4 - 1$
- $x^4 + 6x^2 + 9$
- $x^6 - 4x^3 + 4$
- $9x^2 - 4$

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

- a. $A(x) = 900 - 4x^2$
b. $P(x) = 4(30 - 2x) + 8x = 120$
- a. $f(x) = 15x^6 - 30x^5 + 15x^4$
b. 0.234375
- a. $A(x) = 150 - 4x^2$
b. $P(x) = 2(15 - 2x) + 2(10 - 2x) + 8x = 50$
c. $V(x) = (10 - 2x)(15 - 2x)x = 4x^3 - 50x^2 + 150x$
- a. $A(x) = 400 - 4x^2$
b. $20 - 2x$ and $20 - 2x$
c. $B(x) = 400 - 80x + 4x^2$
d. $V(1) = 400x - 80x^2 + 4x^3$

12.8 Exercises

Concept Check

- rational
- numerator, simplify
- 0
- False; Descending order
- True

Practice

- $y^2 - 2y + 3$
- $2x^2 - 3x + 1$
- $10x^3 - 11x^2 + x$

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 .

12.9 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. $x^3 + 2x^2 + 6x + 9 + \frac{23}{x-2}$
b. $c = 2$; $P(2) = 23$

15. a. $x^3 + \frac{1}{2}x^2 - \frac{3}{4}x - \frac{3}{8}$
 $+ \frac{45}{16\left(x - \frac{1}{2}\right)}$

b. $c = \frac{1}{2}$; $P\left(\frac{1}{2}\right) = \frac{45}{16}$

17. a. $x^4 + x^3 + x^2 + x + 1$

b. $c = 1$; $P(1) = 0$

19. a. $x^3 - \frac{14}{5}x^2 + \frac{56}{25}x - \frac{224}{125}$
 $+ \frac{3396}{625\left(x + \frac{4}{5}\right)}$

b. $c = -\frac{4}{5}$; $P\left(-\frac{4}{5}\right) = \frac{3396}{625}$

Applications

21. 41°F

Collaborative Learning

23. a. Answers will vary.

$x^2 - \frac{7}{2}x + \frac{13}{4} + \frac{73}{4(2x-1)}$;
 $2x^2 - 7x + \frac{13}{2} + \frac{73}{4\left(x - \frac{1}{2}\right)}$

b. $\frac{P(x)}{x - \frac{b}{a}} = \frac{aP(x)}{ax - b}$

c. If a polynomial $P(x)$ is divided by $(ax - b)$, then the remainder will be $P\left(\frac{b}{a}\right)$. Answers will vary.

Chapter 13: Factoring Polynomials

13.1 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.

13.2 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.

13.3 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 $(25 - 2x)$.

13.4 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. $(3x+y^2)(9x^2-3xy^2+y^4)$

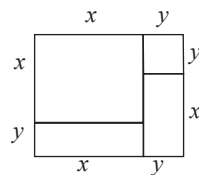
57. $(2x+y)(4x^2-2xy+y^2)$
 59. $8(y-1)(y^2+y+1)$

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. $\frac{x-4}{x+4}$

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).

13.5 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. $(y+10+7x)(y+10-7x)$

13.6 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. $\pi \text{ in.}^2$

b. $4\pi \text{ in.}^2$

c. $16\pi \text{ in.}^2$

d. $64\pi \text{ in.}^2$

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.

13.7 Exercises

Concept Check

- variable, unknown
- consecutive
- 1
- False; The sum of the squares of the lengths of the legs is equal to the hypotenuse squared.
- False: Only with right triangles

Applications

- $x(x+8) = -16$; $x = -4$, so the numbers are -4 and 4.
- $x^2 = 7x$; $x = 0, 7$
- $x^2 + 3x = 28$; $x = 4$
- $x(x+3) = 40$; $x = -8, 5$, so the numbers are -8 and -5 or 5 and 8.
- $(x+5)^2 + x^2 = 53$; $x = 2$, so the numbers are 2 and 7.
- $x + (x+4)^2 = 38$; $x = 2$, so the integers are 2 and 6.
- $x(2x-5) = x+56$; $x = -4$
- $x(x+1) = 72$; $x = 8$, 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 14: Rational Expressions

14.1 Exercises

Concept Check

- rational
- fundamental
- fractions
- True
- False; A rational expression cannot have a zero denominator.

Practice

- $\frac{3x}{4y}; x \neq 0, y \neq 0$
- $\frac{2x^3}{3y^3}; x \neq 0, y \neq 0$
- $\frac{1}{x-3}; x \neq 0, 3$
- $7; x \neq 2$
- $-\frac{3}{4}; x \neq 3$
- $\frac{2x}{y}; x \neq -\frac{2}{3}, y \neq 0$
- $\frac{x}{x-1}; x \neq -6, 1$
- $\frac{x-7}{x-3}; x \neq -3, 3$
- $\frac{x-3}{y-2}; y \neq -2, 2$
- $\frac{x+7}{y+5}; x \neq 2, y \neq -5$
- $\frac{2}{75}$
- 9
- 0
- $\frac{-3}{32}$
- 1

Applications

- 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.

- a. \$11.62 b. \$6.29
c. \$5.33
d. The cost per calculator decreases as the number of calculators purchased increases.
- $x \neq -20$
- The value of x cannot be negative because you cannot buy a negative quantity of calculators

- $(2x-5)$ feet

Writing & Thinking

- 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.

14.2 Exercises

Concept Check

- factor
- numerator, denominator
- numerators, denominators
- True
- False; the restriction is 0.

Practice

- $\frac{ab}{6y}$
- $\frac{8x^2y^3}{15}$

$$5. \frac{x+3}{x}$$

$$7. \frac{x-1}{x+1}$$

$$9. -\frac{1}{x-8}$$

$$11. \frac{x-2}{x}$$

$$13. \frac{4x+20}{x(x+1)}$$

$$15. \frac{x}{(x+3)(x-1)}$$

$$17. -\frac{x+4}{x(x+1)}$$

$$19. \frac{x+2y}{(x-3y)(x-2y)}$$

$$21. \frac{x-1}{x(2x-1)}$$

$$23. \frac{1}{x+1}$$

$$25. \frac{x+2}{x-2}$$

$$27. \frac{1}{3xy^6}$$

$$29. \frac{6y^7}{x^4}$$

$$31. \frac{x}{12}$$

$$33. \frac{6x+18}{x^2}$$

$$35. \frac{6}{5x}$$

$$37. \frac{3x+1}{x+1}$$

$$39. \frac{x-2}{2x-1}$$

$$41. -\frac{x+4}{x(2x-1)}$$

$$43. \frac{x+1}{x-1}$$

$$45. \frac{6x^3-x^2+1}{x^2(4x-3)(x-1)}$$

$$47. \frac{x^2+4x+4}{x^2(2x-5)}$$

$$49. \frac{x^2-6x+5}{(x-7)(x-2)(x+7)}$$

$$51. \frac{x^2-3x}{(x-1)^2}$$

$$53. \frac{x^2+5x}{2x+1}$$

$$55. 1$$

Applications

$$57. \text{ a. } \frac{x^2-3x-10}{x+3}$$

$$\text{ b. } \frac{x^2+5x+6}{x-5}$$

$$\text{ c. } (x+2)^2 = x^2 + 4x + 4$$

14.3 Exercises

Concept Check

- smallest
- prime factorization
- equivalent
- True
- False; You completely factor each polynomial, including prime factors for numerical terms.

Practice

- 150
- 432
- 600
- 60
- $\frac{11}{17}$
- $\frac{3}{2}$
- $\frac{6}{5}$
- $\frac{23}{30}$
- $\frac{28}{27}$
- $7(x+5)(x-5)$
- $30(y-4)$
- $(x+3)(x-3)(x-3)$
- $-(y-3)$
- $-2(x+12)(x-12)$
- $(x+4)(x-3)(x+5)$
- $(x-2)(y+3)(x+7)$
- $2(x+6)(x-6)(x+3)$
- $6(x-5)(y+6)(y+1)$
- $(x+2)(x-2)(x^2+4)$
- 28

$$\begin{aligned}
 41. & 33(x-3) \\
 43. & -3x^2 \\
 45. & 2(y+3)(y-1) \\
 & = 2y^2 + 4y - 6 \\
 47. & (x+1)(x+3) \\
 & = x^2 + 4x + 3
 \end{aligned}$$

14.4 Exercises

Concept Check

1. numerator, denominator
3. most
5. equivalent
7. True
9. True

Practice

$$\begin{aligned}
 1. & 3 \\
 3. & 2 \\
 5. & 1 \\
 7. & \frac{2}{x-1} \\
 9. & \frac{14}{7-x} \\
 11. & 4 \\
 13. & \frac{x^2 - x + 1}{(x+4)(x-3)} \\
 15. & \frac{5}{x-3} \\
 17. & \frac{4x+5}{2(7x-2)} \\
 19. & \frac{6x+15}{(x+3)(x-3)} \\
 21. & \frac{x^2 - 2x + 4}{(x+2)(x-1)} \\
 23. & \frac{-x^2 - 3x - 6}{(x+3)(3-x)} \\
 25. & \frac{8x^2 + 13x - 21}{6(x+3)(x-3)} \\
 27. & \frac{3x^2 - 20x}{(x+6)(x-6)} \\
 29. & \frac{-4x}{x-7} \\
 31. & \frac{4x^2 - x - 12}{(x+7)(x-4)(x-1)} \\
 33. & \frac{x-6}{(x-10)(x-8)}
 \end{aligned}$$

$$\begin{aligned}
 35. & \frac{6x}{(x-1)(x-7)} \\
 37. & \frac{4x-19}{(7x+4)(x-1)(x+2)} \\
 39. & \frac{-7x-9}{(4x+3)(x-2)} \\
 41. & \frac{4x^2 - 41x + 3}{(x+4)(x-4)} \\
 43. & \frac{x-4}{2(x-2)} \\
 45. & \frac{x^2 - 4x - 6}{(x+2)(x-2)(x-1)} \\
 47. & \frac{3x^2 + 26x - 3}{(x+7)(x-3)(x+1)} \\
 49. & \frac{6x+2}{(x-1)(x+3)} \\
 51. & \frac{2x^2 + x - 4}{(x-2)(y+1)(x+1)} \\
 53. & \frac{2x + 4xy - 15y}{(x+3)(y+2)(x-5)} \\
 55. & \frac{-2x+2}{2x-1} \\
 57. & \frac{2x^2 - x - 5}{(x-3)(x+3)(x^2+1)} \\
 59. & \frac{x^2 + 9x + 6}{(3x+1)(x+3)(x-1)}
 \end{aligned}$$

Applications

$$\begin{aligned}
 61. & \text{a. } \frac{7x^2 + 3}{x-2} \quad \text{b. } \frac{4x^2 + 5}{x+2} \\
 & \text{c. } \frac{22x^3 + 12x^2 + 16x - 8}{(x+2)(x-2)} \\
 63. & \frac{5x+6}{2x(x+3)} \\
 65. & \text{a. } \frac{100}{x} \quad \text{b. } \frac{100}{2x+15} \\
 & \text{c. } \frac{100x+1500}{x(2x+15)} \\
 67. & \text{a. } \$5750 \\
 & \text{b. } C(x) = 5750 + 0.35x \\
 & \text{c. } A(x) = \frac{5750 + 0.35x}{x} \\
 & \text{d. } \$6.40 \text{ per cupcake} \\
 & \text{e. } \$1.99 \text{ per cupcake}
 \end{aligned}$$

14.5 Exercises

Concept Check

1. rational

3. LCM
5. complex algebraic
7. True
9. True

Practice

$$\begin{aligned}
 1. & \frac{4}{5xy} \\
 3. & \frac{7x^2y}{2x^2+6x} \\
 5. & \frac{2x-1}{2x-1} \\
 7. & \frac{2+3x}{7} \\
 9. & \frac{2}{2(x+2)} \\
 11. & \frac{x}{x-1} \\
 13. & \frac{4x}{3(x+6)} \\
 15. & \frac{7x}{x+2} \\
 17. & \frac{2x+6}{3(x-2)} \\
 19. & \frac{24y+9x}{2(9y-10x)} \\
 21. & \frac{x}{x-1} \\
 23. & \frac{xy}{x+y} \\
 25. & \frac{1}{xy} \\
 27. & \frac{y+x}{y-x} \\
 29. & \frac{3-x}{x} \\
 31. & \frac{x+1}{x+3} \\
 33. & \frac{-1}{x(x+h)} \\
 35. & \frac{-1}{x(x+h)} \\
 37. & -(x-2y)(x-y) \\
 39. & \frac{2x}{x^2+1} \\
 41. & \frac{(x-3)(x^2-2x+4)}{(x-4)(x-2)(x+1)}
 \end{aligned}$$

$$\begin{aligned}
 43. & \frac{-5}{x+1} \\
 45. & \frac{29}{4(4x+5)}
 \end{aligned}$$

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

Applications

$$\begin{aligned}
 51. & \text{a. } \frac{2r_1r_2}{r_1+r_2} \\
 & \text{b. } 44.2 \text{ miles per hour} \\
 & \text{c. } 1.8 \text{ hours}
 \end{aligned}$$

Writing & Thinking

$$\begin{aligned}
 53. & \text{a. } \frac{8}{5} \\
 & \text{b. } 1 \\
 & \text{c. } \frac{x^4 + x^3 + 3x^2 + 2x + 1}{x^3 + x^2 + 2x + 1}
 \end{aligned}$$

14.6 Exercises

Concept Check

1. ratio
3. extraneous
5. variables
7. False; It is not a proportion.
9. True

Practice

$$\begin{aligned}
 1. & x = 7 \\
 3. & x \neq 0, 2; x = 4 \\
 5. & x \neq -3, 4; x = -10 \\
 7. & x \neq 0; x = 18 \\
 9. & x \neq 6; x = -\frac{74}{9} \\
 11. & x = \frac{1}{4} \\
 13. & x = 6 \\
 15. & x = 4 \\
 17. & x \neq 0; x = \frac{10}{3} \\
 19. & x \neq 0; x = -\frac{3}{4} \\
 21. & x \neq 0; x = -\frac{3}{16} \\
 23. & x \neq -9, -\frac{1}{4}, 0; x = -2, 1 \\
 25. & x \neq \frac{3}{2}, 0, 6; x = \frac{3}{5}, 9
 \end{aligned}$$

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. $R_{\text{total}} = \frac{R_1 R_2}{R_1 + R_2}$

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. $x = \frac{8}{7}$

14.7 Exercises

Concept Check

- unit, time
- check
- diagram, chart
- True

Applications

- 72, 45
- 9
- $\frac{6}{13}$
- 36, 27
- 7, 12
- 37.5 miles
- $\frac{12}{5}$ or $2\frac{2}{5}$ hours
- $\frac{9}{5}$ 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

14.8 Exercises

Concept Check

- decrease
- increase
- 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 cm³

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 15: Roots, Radicals, and Complex Numbers

15.1 Exercises

Concept Check

- 2
- square root
- radical, radicand
- False; If the original number is negative, the

principal square root will not be the same as the original number.

- 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.

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.

15.3 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. $\sqrt[3]{4z^2}$ 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. $\frac{x^{\frac{2}{2}}}{16y^{\frac{5}{2}}}$ 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. $\frac{1}{4}x^{\frac{5}{4}}y^{\frac{5}{4}}$ 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 ft²

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.

15.2 Exercises

Concept Check

1. factor

3. 2

5. $\sqrt{a}\sqrt{b}$

7. True

15.4 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. $xy^2\sqrt[3]{2}(-2x^2y^2 - 2x^3y + 3)$
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. $6x^4\sqrt{2}\%$

15.5 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. $\frac{-(\sqrt{5} + 3)}{4}$
49. $\frac{-6(5 + 3\sqrt{2})}{7}$
51. $\frac{\sqrt{3}(\sqrt{2} - 5)}{23}$
53. $\frac{-7(1 + 3\sqrt{5})}{44}$
55. $\frac{-(\sqrt{3} + \sqrt{5})}{2}$
57. $5(\sqrt{2} - \sqrt{3})$
59. $\frac{4(\sqrt{x} - 1)}{x - 1}$
61. $\frac{5(6 - \sqrt{y})}{36 - y}$
63. $\frac{8(2\sqrt{x} - 3)}{4x - 9}$
65. $\frac{2\sqrt{y}(\sqrt{5y} + \sqrt{3})}{5y - 3}$

67. $\frac{3(\sqrt{x} + \sqrt{y})}{x - y}$
69. $\frac{x(\sqrt{x} - 2\sqrt{y})}{x - 4y}$
71. $-(\sqrt{3} + 1)(\sqrt{3} + 2)$
73. $\frac{-(\sqrt{5} - 2)(\sqrt{5} - 3)}{4}$
75. $\frac{(\sqrt{x} + 1)^2}{x - 1}$
77. $\frac{(\sqrt{x} + 2)(\sqrt{3x} - y)}{3x - y^2}$
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: $(\sqrt{3} + y)(\sqrt{3} + y) \neq 3 + y^2$.

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%

15.6 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. $x = 12$
- 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 $= \text{none}$
 21. E
 23. B
 25. A

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

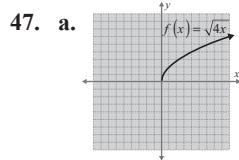
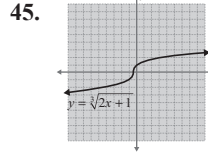
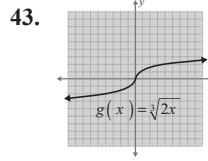
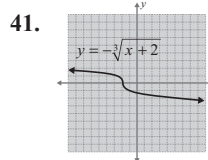
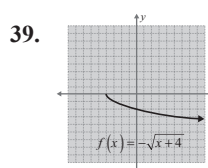
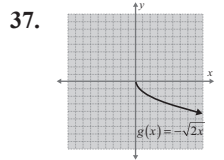
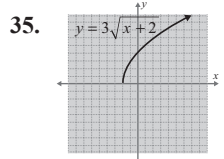
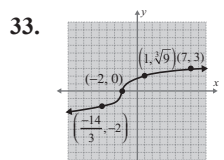
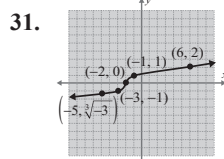
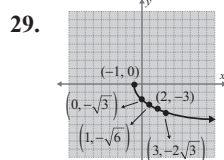
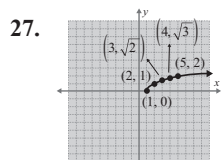
15.7 Exercises

Concept Check

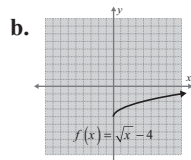
1. ordered
 3. first coordinates
 5. vertical, function
 7. True
 9. True

Practice

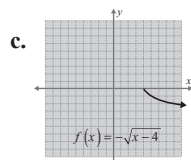
1. a. $\sqrt{5} \approx 2.2361$
 b. 3
 c. $5\sqrt{2} \approx 7.0711$
 d. 2
 3. a. 3
 b. -1



$D = [0, \infty)$; The graph of $\sqrt{x}$ is stretched vertically.



$D = [0, \infty)$; The graph of $\sqrt{x}$ is shifted down four units.

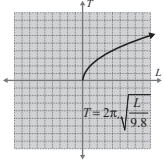


$D = [4, \infty)$; The graph of $\sqrt{x}$ is shifted to the right four units and then reflected across the x-axis.

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 $x = 3$.

15.8 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. $(3 + \sqrt{5}) - 6i$
49. $5 + (\sqrt{6} + 1)i$
51. $\sqrt{3} - 5$
53. $-2 - 5i$
55. $11 - 16i$
57. 2
59. $3 + 4i$

Writing & Thinking

61. a. Yes
b. No

15.9 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. $(2 + \sqrt{10}) + (2\sqrt{2} - \sqrt{5})i$
29. $(9 - \sqrt{30}) + (3\sqrt{5} + 3\sqrt{6})i$
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 16: Quadratic Equations

16.1 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

16.2 Exercises

Concept Check

- trinomial
- 1
- square
- False; It's also possible for there to be one solution.
- True

Practice

- $x^2 - 12x + 36 = (x - 6)^2$
- $x^2 + 6x + 9 = (x + 3)^2$
- $x^2 - 5x + \frac{25}{4} = \left(x - \frac{5}{2}\right)^2$
- $y^2 + y + \frac{1}{4} = \left(y + \frac{1}{2}\right)^2$
- $x^2 + \frac{1}{3}x + \frac{1}{36} = \left(x + \frac{1}{6}\right)^2$
- $2x^2 + 4x + 2 = 2(x + 1)^2$
- $x = -5, 1$
- $y = -1 \pm \sqrt{6}$
- $x = 5 \pm \sqrt{22}$
- $x = -5, 9$
- $x = -5, 8$
- $x = -\frac{4}{3}, 1$
- $x = 3 \pm i$
- $x = 1, 11$
- $y = 5 \pm \sqrt{21}$
- $z = \frac{-3 \pm \sqrt{29}}{2}$
- $x = \frac{-1 \pm i\sqrt{7}}{2}$ or $-\frac{1}{2} \pm \frac{\sqrt{7}}{2}i$
- $x = \frac{-5 \pm \sqrt{17}}{2}$
- $x = \frac{5 \pm \sqrt{10}}{3}$
- $x = -1 \pm i\sqrt{5}$
- $x = \frac{1 \pm i\sqrt{11}}{4}$ or $\frac{1}{4} \pm \frac{\sqrt{11}}{4}i$

$$43. y = \frac{-3 \pm i\sqrt{11}}{2} \text{ or } -\frac{3}{2} \pm \frac{\sqrt{11}}{2}i$$

$$45. y = -\frac{4}{3}, 1$$

$$47. x = 2 \pm \sqrt{2}$$

$$49. x^2 - 7 = 0$$

$$51. x^2 - 2x - 2 = 0$$

$$53. y^2 + 4y - 16 = 0$$

$$55. x^2 + 16 = 0$$

$$57. y^2 + 6 = 0$$

$$59. x^2 - 4x + 5 = 0$$

$$61. x^2 - 2x + 3 = 0$$

$$63. x^2 + 10x + 49 = 0$$

Applications

- $p = 0, 90$
- No income revenue is made if the price is set to \$0 or \$90 per frame.

Writing & Thinking

- See Example 2.

16.3 Exercises

Concept Check

- $ax^2 + bx + c = 0$
- $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
- completing
- True
- False; Two real solutions

Practice

- 68; Two real solutions
- 0; One real solution
- 44; Two nonreal solutions
- 4; Two real solutions
- 19,600; Two real solutions
- 11; Two nonreal solutions
- $x = -2 \pm 2\sqrt{2}$
- $x = -\frac{2}{3}$

$$17. x = 1 \pm i\sqrt{6}$$

$$19. x = -3, \frac{1}{2}$$

$$21. x = \frac{-3 \pm \sqrt{5}}{4}$$

$$23. x = \frac{-3 \pm i\sqrt{3}}{4} \text{ or } -\frac{3}{4} \pm \frac{\sqrt{3}}{4}i$$

$$25. x = \frac{-3 \pm \sqrt{29}}{2}$$

$$27. x = -3, -1$$

$$29. x = \pm 2i\sqrt{2}$$

$$31. x = \frac{5 \pm \sqrt{17}}{2}$$

$$33. x = -\frac{1}{4}$$

$$35. x = \pm \frac{2\sqrt{3}}{3}$$

$$37. x = \frac{2}{3}$$

$$39. x = \frac{-4 \pm i\sqrt{2}}{2} \text{ or } -2 \pm \frac{\sqrt{2}}{2}i$$

$$41. x = \frac{7 \pm i\sqrt{51}}{10} \text{ or } \frac{7}{10} \pm \frac{\sqrt{51}}{10}i$$

$$43. x = -2, \frac{5}{3}$$

$$45. x = 3 \pm i\sqrt{2}$$

$$47. x = -1, 0$$

$$49. x = \frac{9 \pm \sqrt{65}}{2}, 0$$

$$51. x = \frac{-3 \pm \sqrt{5}}{2}, 0$$

$$53. x = \frac{1}{2}, -3$$

$$55. x = -\frac{1}{3}, 3$$

$$57. x = \frac{2 \pm \sqrt{3}}{3}$$

$$59. x = \frac{1 \pm i\sqrt{3}}{6}$$

$$61. x = \frac{2 \pm i\sqrt{2}}{2}$$

$$63. x = \frac{-7 \pm \sqrt{17}}{4}$$

$$65. c < 16$$

$$67. c = \frac{81}{4}$$

$$69. a > 3$$

$$71. a > -\frac{1}{36}$$

$$73. a = \frac{49}{48}$$

$$75. c > \frac{4}{3}$$

$$77. x \approx 2.5993, 60.4007$$

$$79. x \approx -0.7862, 2.0110$$

$$81. x \approx -4.1334, -0.5806$$

$$83. x \approx -2.6933, 2.6933$$

Applications

- 3.35 seconds
- 4.15 seconds
- 0.80 seconds

Writing & Thinking

- $x^4 - 13x^2 + 36 = 0$; multiplied $(x-2)(x+2)(x-3)(x+3)$

16.4 Exercises

Concept Check

- read, think, translate
- diagram
- True

Applications

- $w(2w-5) = 63$; $w = 7$, the rectangle is 7 m by 9 m
- $x + (x+9)^2 = 147$; $x = 3$, the numbers are 3 and 12
- $(w+12)(w+22) = 1344$; $w = 20$, the pool is 20 ft by 30 ft
- $(x+5)^2 = 4x^2$; $x = 5$, the side of the original square is 5 m
- $w^2 + (w+4)^2 = 400$; $w = 12$, the rectangle is 12 m by 16 m
- $x(x+16) = 960$; $x = 24$, 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 am-
 peres

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.

16.5 Exercises

Concept Check

- middle, one-half
- first
- True
- True

Practice

- $x = \pm 2, \pm 3$
- $x = \pm 2, \pm \sqrt{5}$

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

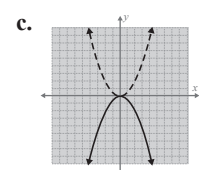
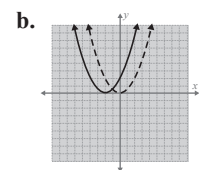
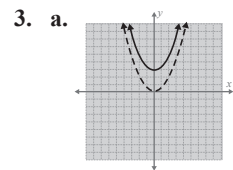
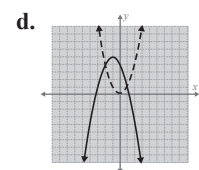
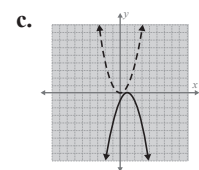
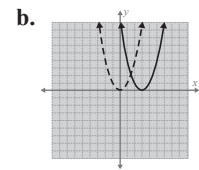
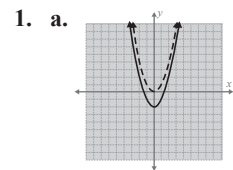
- b. 97.08 feet
 c. Rectangle B is "golden."

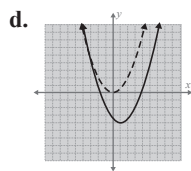
16.6 Exercises

Concept Check

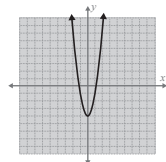
- parabola
- $\geq$
- range
- False; It is a horizontal
 shift (or horizontal trans-
 lation).

Practice

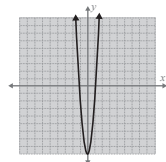




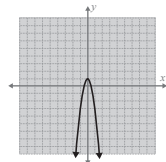
5. $x = 0; (0, -4)$



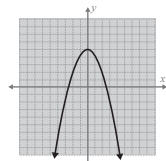
7. $x = 0; (0, -9)$



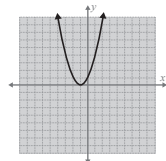
9. $x = 0; (0, 1)$



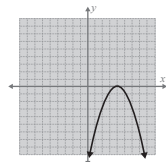
11. $x = 0; (0, 5)$



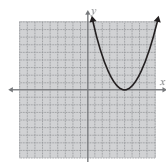
13. $x = -1; (-1, 0)$



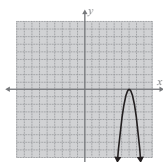
15. $x = 4; (4, 0)$



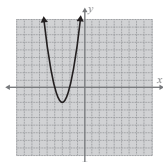
17. $x = 5; (5, 0)$



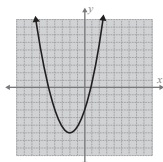
19. $x = 6; (6, 0)$



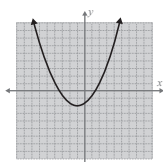
21. $x = -3; (-3, -2)$



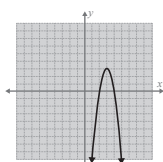
23. $x = -2; (-2, -6)$



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 .

16.7 Exercises

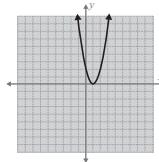
Concept Check

- vertex
- x -axis
- downward, highest, maximum
- False; The line of symmetry is at $x = -\frac{b}{2a}$.

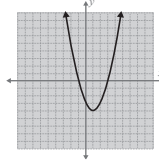
9. True

Practice

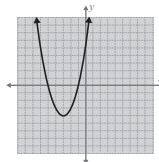
1. $y = 2(x-1)^2; x = 1;$
Vertex: $(1, 0); x$ -int: $(1, 0);$
 y -int: $(0, 2)$



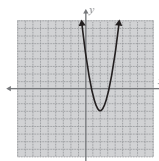
3. $y = (x-1)^2 - 4; x = 1;$
Vertex: $(1, -4);$
 x -int: $(-1, 0), (3, 0);$
 y -int: $(0, -3)$



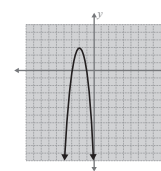
5. $y = (x+3)^2 - 4; x = -3;$
Vertex: $(-3, -4);$
 x -int: $(-5, 0), (-1, 0);$
 y -int: $(0, 5)$



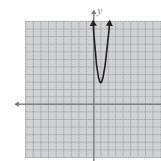
7. $y = 2(x-2)^2 - 3; x = 2;$
Vertex: $(2, -3);$
 x -int: $\left(\frac{4+\sqrt{6}}{2}, 0\right),$
 $\left(\frac{4-\sqrt{6}}{2}, 0\right);$
 y -int: $(0, 5)$



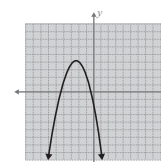
9. $y = -3(x+2)^2 + 3;$
 $x = -2;$ Vertex: $(-2, 3);$
 x -int: $(-1, 0), (-3, 0);$
 y -int: $(0, -9)$



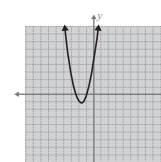
11. $y = 5(x-1)^2 + 3;$
 $x = 1;$ Vertex: $(1, 3);$
 x -int: None; y -int: $(0, 8)$



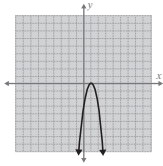
13. $y = -\left(x + \frac{5}{2}\right)^2 + \frac{17}{4};$
 $x = -\frac{5}{2};$
Vertex: $\left(-\frac{5}{2}, \frac{17}{4}\right);$
 x -int: $\left(\frac{-5+\sqrt{17}}{2}, 0\right),$
 $\left(\frac{-5-\sqrt{17}}{2}, 0\right);$
 y -int: $(0, -2)$



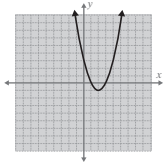
15. $y = 2\left(x + \frac{7}{4}\right)^2 - \frac{9}{8};$
 $x = -\frac{7}{4};$
Vertex: $\left(-\frac{7}{4}, -\frac{9}{8}\right);$
 x -int: $\left(-\frac{5}{2}, 0\right), (-1, 0);$
 y -int: $(0, 5)$



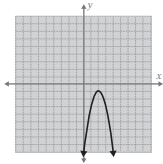
17. $x = 1$; Vertex: $(1, 0)$;
 x -int: $(1, 0)$; y -int: $(0, -3)$



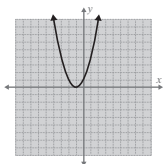
19. $x = 2$; Vertex: $(2, -1)$;
 x -int: $(3, 0), (1, 0)$;
 y -int: $(0, 3)$



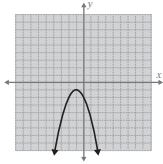
21. $x = 2$; Vertex: $(2, -1)$;
 x -int: None; y -int: $(0, -9)$



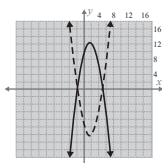
23. $x = -1$; Vertex: $(-1, 0)$;
 x -int: $(-1, 0)$; y -int: $(0, 1)$



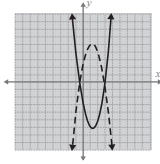
25. $x = -1$; Vertex: $(-1, -1)$;
 x -int: None; y -int: $(0, -2)$



27. a. No b. Yes
 c. One function is a reflection of the other across the x -axis.



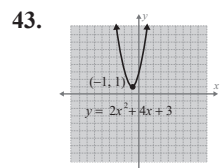
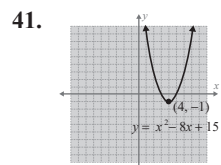
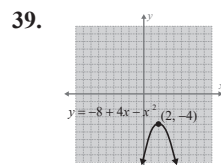
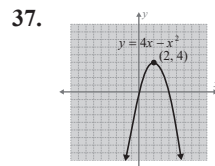
29. a. No b. Yes
 c. One function is a reflection of the other across the x -axis.



31. Zeros: $x \approx -0.7321, 2.7321$

33. Zeros: $x \approx -1.1583, 2.1583$

35. No real zeros



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 yd²

Writing & Thinking

55. a. Parabola b. $x = -\frac{b}{2a}$
 c. $x = -\frac{b}{2a}$

- d. No. A graph can be entirely above or below the x -axis.

16.8 Exercises

Concept Check

- graphs
- endpoints
- bracket, parenthesis
- False; The goal is to get 0 on one side of the inequality and factor the other side.
- False; The solution consists of all intervals where the test points satisfy the original inequality.

Practice

- $(-2, 6)$
- $(-\infty, \frac{2}{3}) \cup (5, \infty)$
- $(-\infty, -7] \cup [\frac{5}{2}, \infty)$
- $[-2, -\frac{1}{3}]$

- $(-\infty, -\frac{4}{3}) \cup (0, 5)$

- $\{-2\}$

- $(-\infty, -\frac{5}{2}) \cup (3, \infty)$

15. $(-\frac{1}{4}, \frac{3}{2})$

17. $(-\infty, \frac{1}{2}] \cup [2, \infty)$

19. $(-\frac{2}{3}, -\frac{1}{2})$

21. $(-\infty, \frac{5}{2}) \cup (\frac{5}{2}, \infty)$

23. $[\frac{5}{2}, \frac{7}{4}]$

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. $(-\frac{2}{3}, 2)$

39. $(-\infty, -1 - \sqrt{5}) \cup (-1 + \sqrt{5}, \infty)$

41. $(-\infty, -3 - \sqrt{2}] \cup [-3 + \sqrt{2}, \infty)$

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. $\emptyset$

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. $\emptyset$

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 17: Exponential and Logarithmic Functions

17.1 Exercises

Concept Check

- composition, inverses
- domain
- y -values, x
- True
- False; The operations are restricted to the portions of the domain that are in common.

Practice

- a. $2x - 3$
b. 7
c. $x^2 - 3x - 10$
d. $\frac{x+2}{x-5}, x \neq 5$
- 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

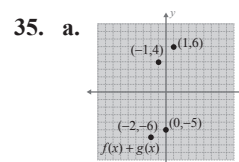
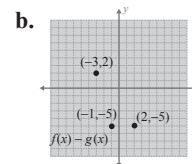
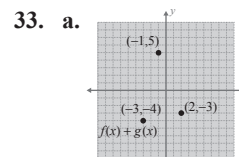
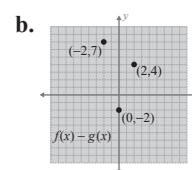
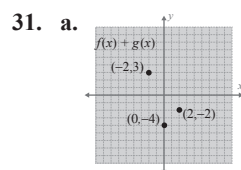
21. $\sqrt{2x-6} + x + 4,$
 $D = [3, \infty)$

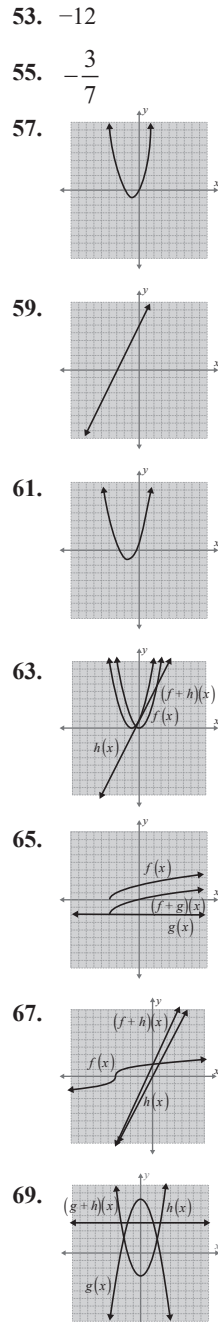
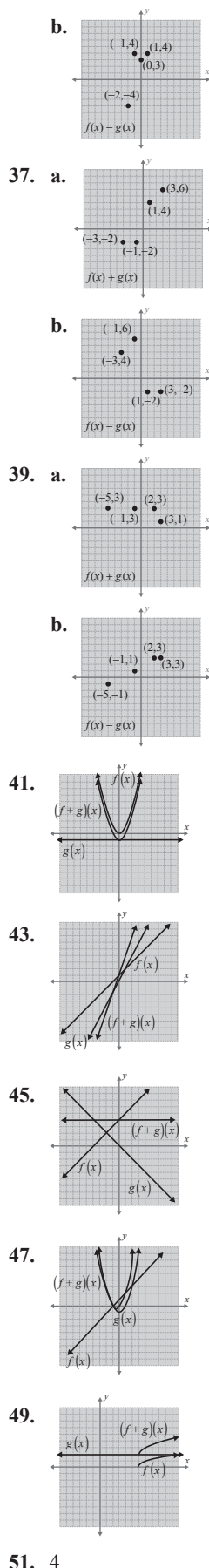
23. $3x^2 - 19x - 14;$
 $D = (-\infty, \infty)$

25. $\frac{x-5}{\sqrt{x+3}}; D = (-3, \infty)$

27. $-3x\sqrt{x-3}; D = [3, \infty)$

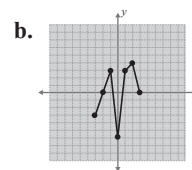
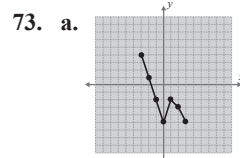
29. $\sqrt[3]{x+3} + \sqrt{5+x};$
 $D = [-5, \infty)$





Writing & Thinking

71. In general, subtraction is not commutative. Answers will vary.



c. $\frac{f}{g}$ is undefined for $x = -2$ as $g(-2) = 0$.

17.2 Exercises

Concept Check

- variable, variable
- $\neq$
- one-to-one
- False; The vertical line test determines whether a graph represents a function.
- True

Practice

- a. $8r - 5$
b. $24a - 13$
- a. $5x^2 - 20x + 24$
b. $45n^4 + 4$
- a. $3n^2 - 6n - 9$
b. $48y^6 + 24y^3 - 9$
- $f(g(2)) = 14$
 $g(f(2)) = \frac{15}{2}$

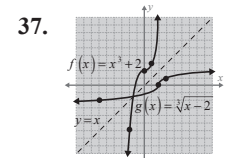
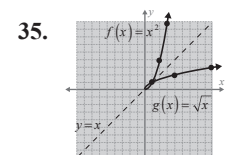
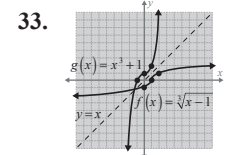
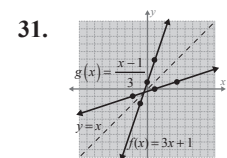
- $(f \circ g)(-5) = 49$
 $(g \circ f)(-1) = 5$
- $f(g(x)) = \sqrt{x^2} = |x|$
 $g(f(x)) = (\sqrt{x})^2 = x$

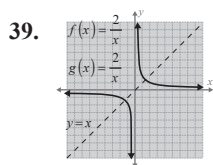
- $f(g(x)) = \sqrt{x-2}$
 $g(f(x)) = \sqrt{x} - 2$

- $f(g(x)) = \frac{1}{x^2} - 1$
 $g(f(x)) = \frac{1}{(x-1)^2}$

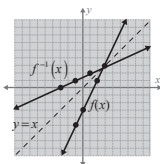
- $f(g(x)) = x^3 + 3x^2 + 4x + 3$
 $g(f(x)) = x^3 + x + 2$

- $f(g(x)) = \frac{1}{|x|}$
 $g(f(x)) = \frac{1}{x}$
- $f(g(x)) = \frac{1}{x^2 + 7x - 8}$
 $g(f(x)) = \left(\frac{1}{x}\right)^2 + 7\left(\frac{1}{x}\right) - 8$
- $f(g(x)) = (2x - 6)^{3n}$
 $g(f(x)) = 2x^{3n} - 6$
- $f(g(x)) = (x - 8)^{\frac{3}{2}}$
 $g(f(x)) = \sqrt{x^3 - 8}$
- a. 21
b. 2
c. No; $f(g(x)) \neq x$ and $g(f(x)) \neq x$
- 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.

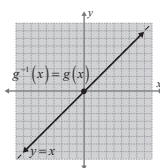




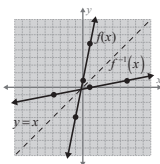
41. $f^{-1}(x) = \frac{x+3}{2}$



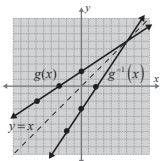
43. $g^{-1}(x) = x$



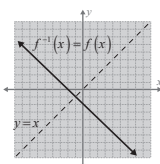
45. $f^{-1}(x) = \frac{x-1}{5}$



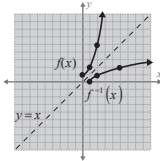
47. $g^{-1}(x) = \frac{3(x-2)}{2}$



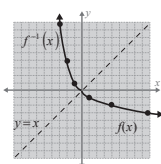
49. $f^{-1}(x) = -x - 2$



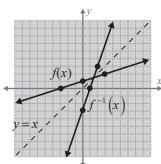
51. $f^{-1}(x) = \sqrt{x-1}$



53. $f^{-1}(x) = x^2, x \leq 0$



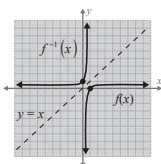
55. One-to-one



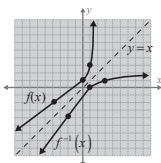
57. Not one-to-one

59. Not one-to-one

61. One-to-one



63. One-to-one



65. One-to-one

67. Not one-to-one

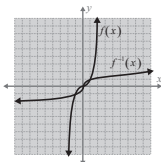
69. One-to-one

71. One-to-one

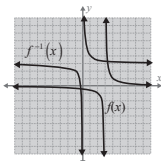
73. One-to-one

75. Not one-to-one

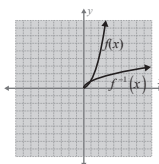
77. $f^{-1}(x) = \sqrt[3]{x}$



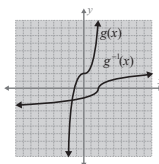
79. $f^{-1}(x) = \frac{1}{x} + 3$



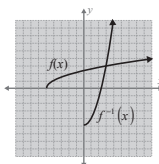
81. $f^{-1}(x) = \sqrt{x}$



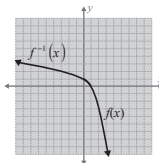
83. $g^{-1}(x) = \sqrt[3]{x-2}$



85. $f^{-1}(x) = x^2 - 5, x \geq 0$



87. $f^{-1}(x) = \sqrt{1-x}$



Writing & Thinking

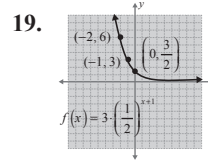
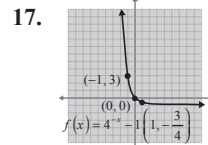
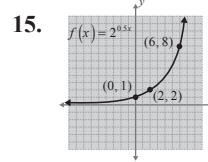
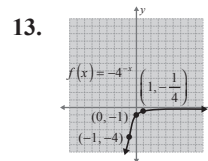
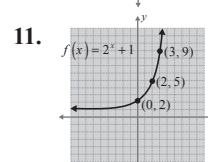
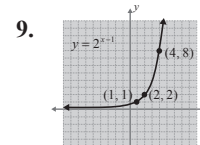
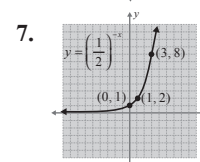
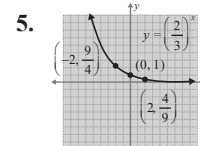
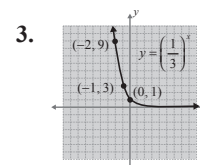
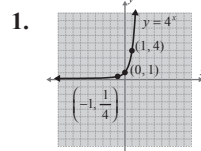
89. The domain of $f(g(x))$ can only include values of x in the domain of g , while $g(f(x))$ can only include values of x in the domain of f . For example, $f(x) = \sqrt{x}$, $g(x) = -x$. Answers will vary.

17.3 Exercises

Concept Check

1. constant, variable
3. 0, 1
5. compound
7. False; $b > 0$ and $b \neq 1$
9. True

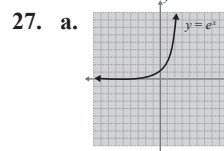
Practice

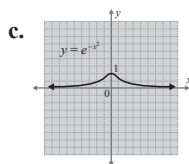
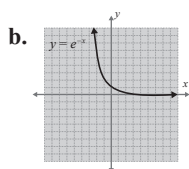


21. 48

23. 12.27

25. 4108.87





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.

17.4 Exercises

Concept Check

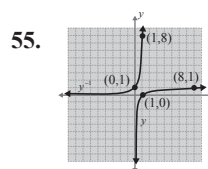
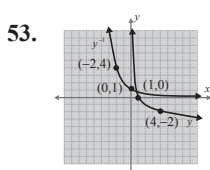
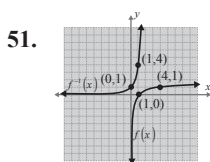
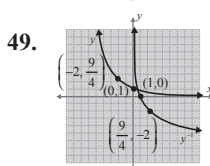
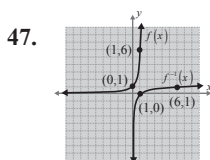
1. $\log_b x$
 3. logarithmic
 5. reflecting
 7. True
 9. True

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. $x = 2$



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 $y = x$.

17.5 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. $\log_5 (2x^3 + x^2)$

49. $\log_2 (x^2 + 2x - 3)$

51. $\log_b (x + 1)$

53. $\log_{10} \left(\frac{1}{2x - 3} \right)$

Writing & Thinking

55. Answers will vary.

17.6 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

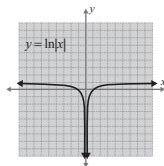
41. 0.0002

43. 1.0403

Writing & Thinking

45. $\log x$ is a base 10 logarithm. $\ln x$ is a base e logarithm.

47. $D = (-\infty, 0) \cup (0, \infty)$



17.7 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.

17.8 Exercises

Concept Check

- decomposition, centuries
- Richter
- False; The variable t is measured in days.

Applications

- \$4027.51
- 11.55 years
- $f \approx 0.30$
- 1.73 hours
- 10.99 days
- 7.44 hours
- 2350.02 years
- 2.31 days
- 39.65 minutes
- 7.00 years
- 5600 years
- a. 13.86 years
b. 6.93 years
- 100
- 8.64 million
- 2083, 2437, 2744
- a. 117.95 dB
b. $3.16 \times 10^8 I_0$
c. $10^6 I_0$

Chapter 18: Conic Sections

18.1 Exercises

Concept Check

- slope, two
- horizontal
- shape, direction
- 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. $2x^2 + 4xh - 3x + 2h^2 - 3h$

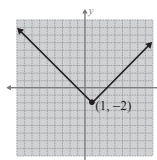
d. $4x + 2h - 3$

5. 1

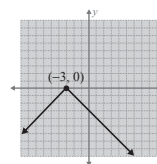
7. -2

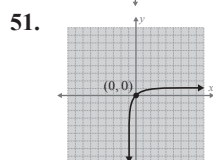
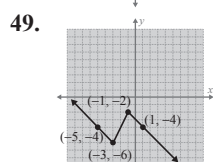
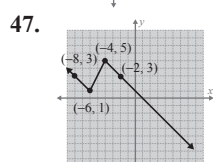
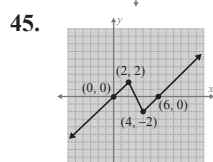
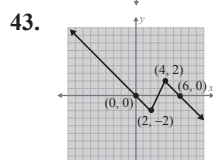
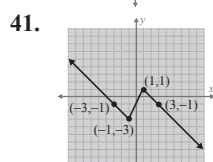
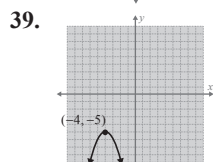
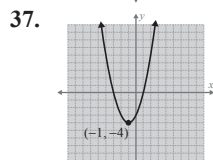
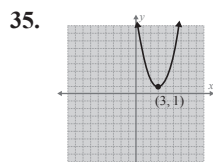
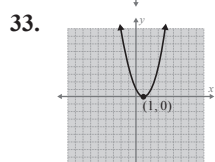
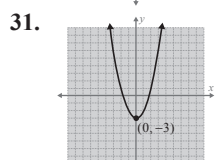
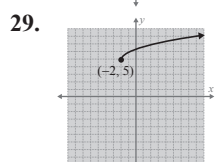
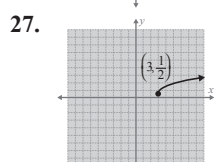
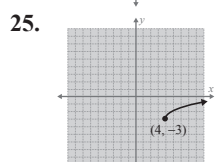
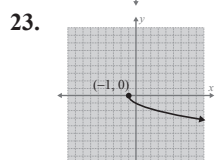
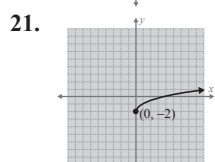
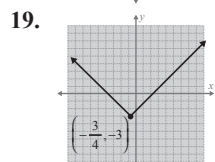
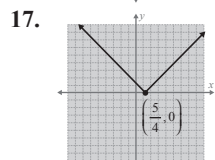
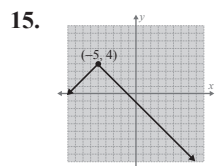
9. The results are the coefficients of x .

11.

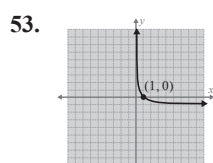


13.

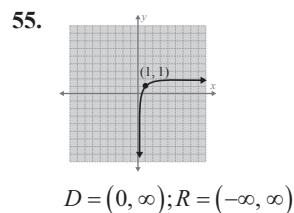




$D = (-1, \infty); R = (-\infty, \infty)$



$D = (0, \infty); R = (-\infty, \infty)$

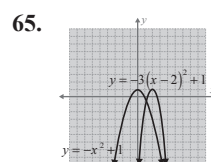
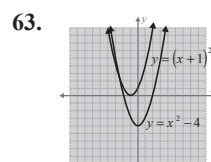
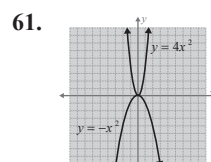


Applications

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.



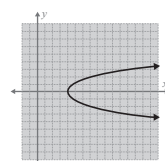
18.2 Exercises

Concept Check

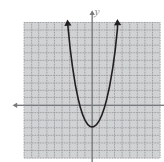
- circle, ellipse, parabola, hyperbola
- vertical
- 0, y -intercepts
- True
- False; $y = k$ is the line of symmetry for a horizontal parabola.

Practice

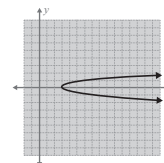
- a. (4, 0) b. None
c. $y = 0$



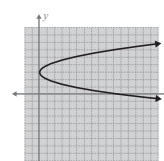
- a. (0, -3) b. (0, -3)
c. $x = 0$



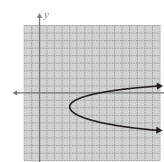
- a. (3, 0) b. None
c. $y = 0$



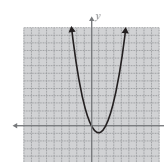
- a. (0, 3) b. (0, 3)
c. $y = 3$



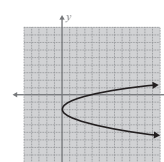
- a. (4, -2) b. None
c. $y = -2$



- a. (1, -1) b. (0, 0)
c. $x = 1$

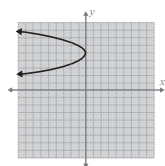


- a. (0, -2) b. (0, -2)
c. $y = -2$



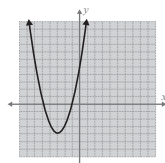
15. a. $(0, 5)$ b. $(0, 5)$

c. $y = 5$



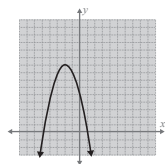
17. a. $(-3, -4)$ b. $(0, 5)$

c. $x = -3$



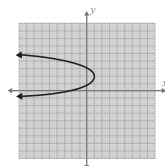
19. a. $(-2, 9)$ b. $(0, 5)$

c. $x = -2$



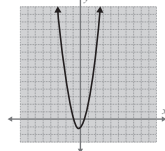
21. a. $(1, 2)$ b. $(0, 1), (0, 3)$

c. $y = 2$



23. a. $(-\frac{1}{4}, -\frac{9}{8})$ b. $(0, -1)$

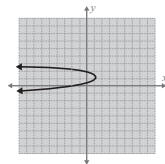
c. $x = -\frac{1}{4}$



25. a. $(\frac{9}{8}, \frac{5}{4})$

b. $(0, \frac{1}{2}), (0, 2)$

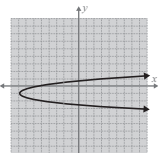
c. $y = \frac{5}{4}$



27. a. $(-8, -1)$

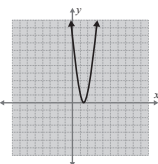
b. $(0, -1 + \frac{2\sqrt{6}}{3}), (0, -1 - \frac{2\sqrt{6}}{3})$

c. $y = -1$

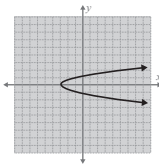


29. a. $(\frac{3}{2}, 0)$ b. $(0, 9)$

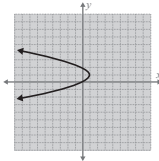
c. $x = \frac{3}{2}$



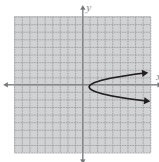
31. $(0, 1.225), (0, -1.225)$



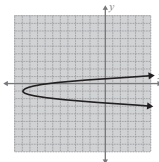
33. $(0, 2), (0, 0)$



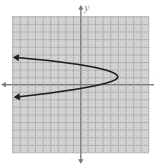
35. No y-intercept



37. $(0, 0.658), (0, -2.658)$



39. $(0, 2.581), (0, -0.581)$



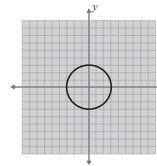
41. b

43. c

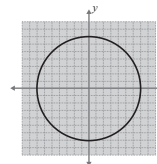
Writing & Thinking

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 $x = y^2$.

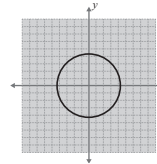
33. $x^2 + y^2 = 9$

Center: $(0, 0)$; $r = 3$ 

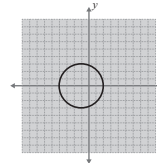
35. $x^2 + y^2 = 49$

Center: $(0, 0)$; $r = 7$ 

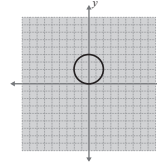
37. $x^2 + y^2 = 18$

Center: $(0, 0)$; $r = 3\sqrt{2}$ 

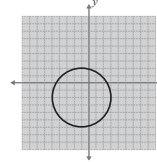
39. $(x+1)^2 + y^2 = 9$

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: $(-1, -2)$; $r = 4$ 

18.3 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. $(x-4)^2 + y^2 = 1$

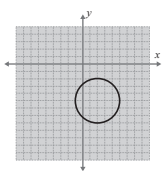
25. $(x+2)^2 + y^2 = 8$

27. $(x-3)^2 + (y-1)^2 = 36$

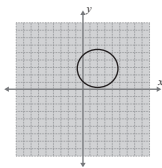
29. $(x-3)^2 + (y-5)^2 = 12$

31. $(x-7)^2 + (y-4)^2 = 10$

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

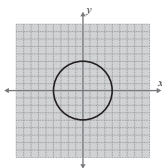
51. $\overline{AB} = \overline{AC} = 4\sqrt{5}$

53. $\overline{AB} = \overline{AC} = \overline{BC} = 4$

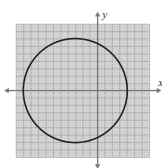
55. $\overline{AC} = \overline{BD} = \sqrt{61}$

57. $10 + 4\sqrt{5}$

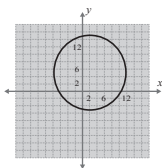
59.



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.

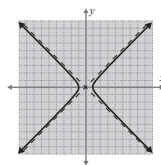
$x + p = \sqrt{(x-p)^2 + y^2}$

$(x + p)^2 = (x - p)^2 + y^2$

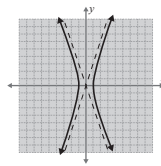
$x^2 + 2px + p^2 = x^2 - 2px + p^2 + y^2$

$y^2 = 4px$

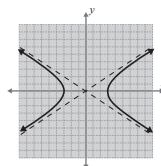
7. $\frac{x^2}{1} - \frac{y^2}{1} = 1$



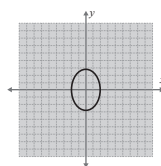
9. $\frac{x^2}{1} - \frac{y^2}{9} = 1$



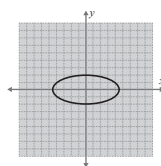
11. $\frac{x^2}{9} - \frac{y^2}{4} = 1$



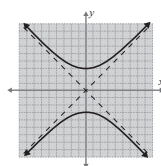
13. $\frac{x^2}{4} + \frac{y^2}{8} = 1$



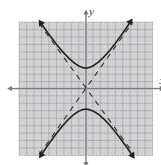
15. $\frac{x^2}{20} + \frac{y^2}{4} = 1$



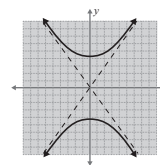
17. $\frac{y^2}{9} - \frac{x^2}{9} = 1$



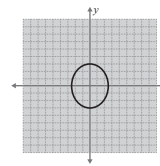
19. $\frac{y^2}{8} - \frac{x^2}{4} = 1$



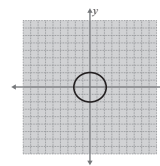
21. $\frac{y^2}{18} - \frac{x^2}{9} = 1$



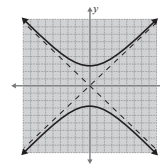
23. $\frac{x^2}{6} + \frac{y^2}{9} = 1$



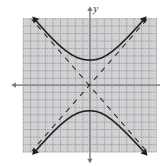
25. $\frac{x^2}{5} + \frac{y^2}{4} = 1$



27. $\frac{y^2}{8} - \frac{x^2}{9} = 1$



29. $\frac{y^2}{12} - \frac{x^2}{9} = 1$

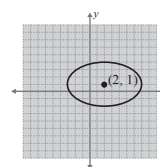


31. c

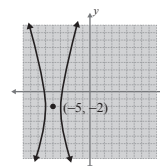
33. d

35. b

37.



39.



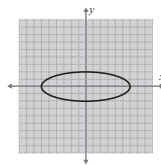
18.4 Exercises

Concept Check

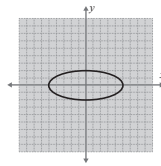
- oval
- focus
- minor
- True
- False; The midway point between the foci is the center.

Practice

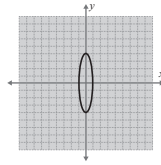
1. $\frac{x^2}{36} + \frac{y^2}{4} = 1$



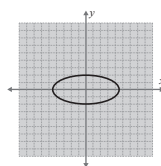
3. $\frac{x^2}{25} + \frac{y^2}{4} = 1$



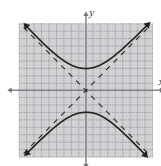
5. $\frac{x^2}{1} + \frac{y^2}{16} = 1$



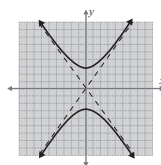
15. $\frac{x^2}{20} + \frac{y^2}{4} = 1$

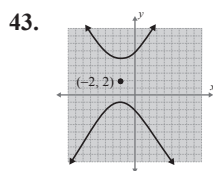
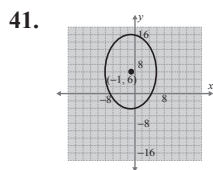


17. $\frac{y^2}{9} - \frac{x^2}{9} = 1$



19. $\frac{y^2}{8} - \frac{x^2}{4} = 1$





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
- $$a^2 = b^2 + c^2.$$

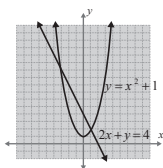
18.5 Exercises

Concept Check

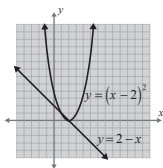
- second
- substitution, addition
- both
- True
- False; There are many situations where the curves do not intersect.

Practice

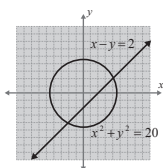
1. $(-3, 10), (1, 2)$



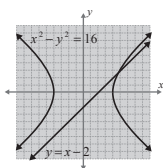
3. $(1, 1), (2, 0)$



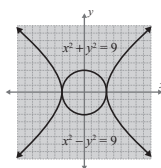
5. $(-2, -4), (4, 2)$



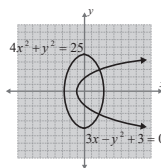
7. $(5, 3)$



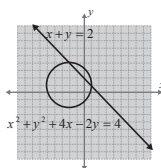
9. $(-3, 0), (3, 0)$



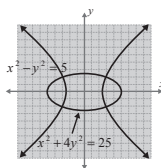
11. $(2, 3), (2, -3)$



13. $(-2, 4), (1, 1)$



15. $(-3, -2), (3, 2), (-3, 2), (3, -2)$



17. $(-3\sqrt{5}, 5), (-6, 4), (3\sqrt{5}, 5), (6, 4)$

19. $(1, 3), (-1, 3)$

21. $(4, 4), (-2, -2)$

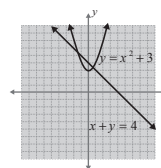
23. $\left(-\frac{3}{2}, -1\right), \left(\frac{1}{2}, \frac{1}{2}\right)$

25. $(-3, \sqrt{11}), (-3, -\sqrt{11}), (3, \sqrt{11}), (3, -\sqrt{11})$

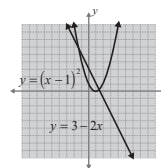
27. $(5, -3), (-5, 1)$

29. $(0, 3), (2, 3)$

31. $(-1.62, 5.62), (0.62, 3.38)$



33. $(1.41, 0.17), (-1.41, 5.83)$



35. $(2.68, 1.68), (-1.68, -2.68)$

