

Chapter 1

Introduction to Algebraic Expressions

Exercise Set 1.1

1. Expression
2. Equation
3. Equation
4. Expression
5. Equation
6. Equation
7. Expression
8. Equation
9. Equation
10. Expression
11. Expression
12. Expression
13. Substitute 9 for a and multiply.
 $3a = 3 \cdot 9 = 27$
14. Substitute 7 for x and multiply.
 $8x = 8 \cdot 7 = 56$
15. Substitute 2 for t and add.
 $t + 6 = 2 + 6 = 8$
16. Substitute 9 for r and subtract.
 $13 - r = 13 - 9 = 4$
17. Substitute 2 for x , 14 for y . Add and then divide the sum by 4.
 $\frac{x + y}{4} = \frac{2 + 14}{4} = \frac{16}{4} = 4$
18. Substitute 15 for c , 20 for d , add and then divide the sum by 7.
 $\frac{c + d}{7} = \frac{15 + 20}{7} = \frac{35}{7} = 5$

19. Substitute 20 for m , 6 for n , subtract and then divide the difference by 2.

$$\frac{m - n}{2} = \frac{20 - 6}{2} \\ = \frac{14}{2} = 7$$

20. Substitute 23 for x , 5 for y , subtract and divide the difference by 6.

$$\frac{x - y}{6} = \frac{23 - 5}{6} = \frac{18}{6} = 3$$

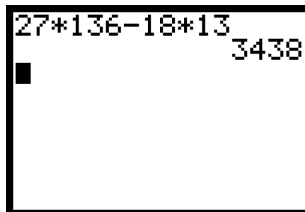
21. Substitute 6 for m and 18 for q .

$$\frac{9m}{q} = \frac{9 \cdot 6}{18} = \frac{54}{18} = 3$$

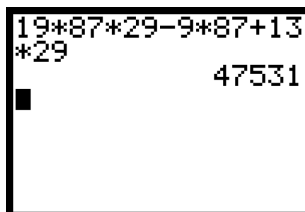
22. Substitute 9 for z and 15 for y .

$$\frac{5z}{y} = \frac{5 \cdot 9}{15} = \frac{45}{15} = 3$$

23. Enter the expression in the graphing calculator, replacing a with 136 and b with 13. We see that $27a - 18b = 3438$ for $a = 136$ and $b = 13$.



24. Enter the expression in the graphing calculator, replacing x with 87 and y with 29. We see that $19xy - 9x + 13y = 47,531$ for $x = 87$ and $y = 29$.



25. $A = bh$
 $= (6\text{ft})(3\frac{1}{2}\text{ft})$
 $= (6)(3\frac{1}{2})(\text{ft})(\text{ft})$
 $= 21\text{ft}^2$, or 21 square feet
26. $t = \frac{1400}{v}$
 $= \frac{1400\text{mi}}{400\text{mph}} = 3.5\text{ hr}$
27. $A = \frac{1}{2} \cdot bh$
 $= \frac{1}{2}(5\text{cm})(6\text{cm})$
 $= \frac{1}{2}(5)(6)(\text{cm})(\text{cm})$
 $= 15\text{cm}^2$, or 15 square centimeters
28. a. $t = 30\text{ sec}$. By substitution,
 $2t = 2 \cdot 30\text{ sec} = 60\text{ sec}$
 b. $t = 35\text{ min}$. By substitution,
 $2t = 2 \cdot 35\text{ min} = 70\text{ min}$
 c. $t = 2\frac{1}{2}\text{ hr}$. By substitution,
 $2t = 2 \cdot 2\frac{1}{2}\text{ hr} = 5\text{ hr}$
29. $A = bh$
 $= (67\text{ft})(12\text{ft})$
 $= (67)(12)(\text{ft})(\text{ft})$
 $= 804\text{ft}^2$, or 804 square feet
30. Average $= \frac{h}{a}$
 $= \frac{8}{22} \approx 0.364$
31. Let r represent Ron's age. 5 more than Ron's age, or Ron's age plus 5 can be expressed as $5 + r$, or $r + 5$
32. Let s represent Luke's speed. Times means multiplication, so we have $s \cdot 8$, or $8s$
33. Product is the result of multiplication, so we have $a \cdot 4$, or $4a$
34. Let l represent Lou's weight; $l + 7$ or $7 + l$
35. 9 less than c ; $c - 9$
36. 4 less than d ; $d - 4$
37. 6 increased by q ; to increase is to add; $6 + q$, or $q + 6$
38. 11 increased by z ; to increase is to add; $11 + z$, or $z + 11$
39. The difference of m and n ; $m - n$
40. t subtracted from p ; $p - t$
41. x less than y , or decrease y by x ; $y - x$
42. Let a represent Lorrie's age; $a - 2$
43. x divided by w (Note: x is the dividend, or numerator, and w is the divisor, or denominator); $\frac{x}{w}$, or $x \div w$
44. Let s and t represent the two numbers; quotient is the result of division; $s \div t$, or $\frac{s}{t}$
45. Let l and h represent the box's length and height, respectively. We have the sum $l + h$ or $h + l$.
46. Sum of d and f ; $d + f$, or $f + d$
47. Let p represent Panya's speed and let w represent the speed of the wind. $p - 2w$
48. The product of 9 and twice m . Twice m is $2 \cdot m$, or $2m$. We have $9 \cdot 2m$, or $2m \cdot 9$
49. Let y represent "some number"; $\frac{1}{4}y - 12$, or $\frac{y}{4} - 12$
50. Let n represent the number; $6n - 20$
51. Let a and b represent the numbers; $8(a - b)$
52. One third of the sum is $\frac{1}{3} \cdot \text{sum}$; let x and y represent the two numbers. We have $\frac{1}{3} \cdot \text{sum} = \frac{1}{3}(x + y)$

53. $64\% = 0.64$, so 64% of w , where w = the number of women, is $0.64w$. (Note: replace "of" with multiplication)
54. Let y = the number; $38\% = 0.38$, so we have $0.38y$.
55. $x + 17 = 32$ Writing the equation
 $\frac{x+17}{32} \ ? \ 32$ Substituting 15 for x
 $32 \mid 32$ $32 = 32$ is TRUE
 Since the left-hand and right-hand sides are the same, 15 is a solution.
56. $y + 28 = 93$ Writing the equation
 $\frac{y+28}{103} \ ? \ 93$ Substituting 75 for y
 $103 \mid 93$ $103 = 93$ is FALSE
 No; since the left-hand and right-hand sides are not the same, 75 is not a solution.
57. $a - 28 = 75$ Writing the equation
 $\frac{93-28}{65} \ ? \ 75$ Substituting 93 for a
 $65 \mid 75$ $65 = 75$ is FALSE
 Since the left-hand and right-hand sides are not the same, 93 is not a solution.
58. $8t = 96$ Writing the equation
 $\frac{8 \cdot 12}{96} \ ? \ 96$ Substituting 12 for t
 $96 \mid 96$ $96 = 96$ is TRUE
 Since the left-hand and right-hand sides are the same, 12 is a solution.
59. $\frac{t}{7} = 9$
 $\frac{63}{7} \ ? \ 9$
 $9 \mid 9$ $9 = 9$ is TRUE
 Since the left-hand and right-hand sides are the same, 63 is a solution.
60. $\frac{x}{8} = 6$
 $\frac{52}{8} \ ? \ 6$
 $6.5 \mid 6$ $6.5 = 6$ is FALSE
 Since the left-hand and right-hand sides are not the same, 52 is not a solution.

61. $\frac{108}{x} = 36$
 $\frac{108}{3} \ ? \ 36$
 $36 \mid 36$ $36 = 36$ is TRUE
 Since the left-hand and right-hand sides are the same, 3 is a solution.

62. $\frac{94}{y} = 12$
 $\frac{94}{7} \ ? \ 12$
 $13\frac{3}{7} \mid 12$ $13\frac{3}{7} = 12$ is FALSE.

Since the left-hand and right-hand sides are not the same, 7 is not a solution.

63. Let x represent the number.
 7 times what number is 1596?
 $\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$
 Translating: $7 \cdot x = 1596$
 $7x = 1596$

64. Let x represent the number.
What number added to 73 is 201?
 $\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$
 Translating: $x + 73 = 201$

65. Let x represent the number.
 Rewording: 42 times what number is 2352?
 $\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$
 Translating: $42 \cdot x = 2352$
 $42x = 2352$

66. Let x represent the number.
 Rewording: what number plus 345 is 987?
 $\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$
 Translating: $x + 345 = 987$

67. Let s represent the number of unoccupied squares.
 Rewording: Number of occupied plus number of unoccupied is 64.
 $\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$
 Translating: $19 + s = 64$

68. Let
- h
- represent the number of hours.

Rewording: \$35 times the number of hours is \$3150
$$\begin{array}{ccccccc} \downarrow & \downarrow & & \downarrow & & \downarrow & \downarrow \\ \text{Translating: } \$35 & \cdot & & h & & = & \$3150 \\ \$35h = \$3150 & & & & & & \end{array}$$

69. Let
- w
- represent the total amount of waste generated, in millions of tons.

Rewording: 33.4% of the total amount of waste is 85 million tons.
$$\begin{array}{ccccccc} \downarrow & \downarrow & & \downarrow & & \downarrow & \downarrow \\ \text{Translating: } 33.4\% & \cdot & & w & & = & 85 \\ 33.4\% w = 85, \text{ or } 0.334 w = 85 & & & & & & \end{array}$$

70. Let
- t
- represent the average commute in Fort Bliss in minutes.

Rewording: The average commuting time in Fort Bliss is The average commuting time in Indian Wells minus 51.2 min.

$$\begin{array}{ccccccc} \downarrow & \downarrow & & \downarrow & & \downarrow & \downarrow \\ \text{Translating: } & t & = & 59.8 & - & & 51.2 \end{array}$$

71. f

72. h

73. d

74. c

75. g

76. b

77. e

78. a.

79. Look for a pattern in the data. Observe that the daily recommended number of grams of dietary fiber for each age is 5 more than that age. We reword and translate.

Grams of fiber is 5 more than the age
$$\begin{array}{ccccccc} \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \\ f & = & 5 & + & & a & \end{array}$$

We have $f = 5 + a$. This equation could also be written as $f = a + 5$.

80. Observe that the tuition is 100 times the number of class hours. Reword and translate.

Tuition is 100 times number of class hours

$$\begin{array}{ccccccc} \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \\ c & = & 100 & \cdot & & h & \end{array}$$
We have $c = 100h$.

81. Look for a pattern in the data. Observe that it costs \$2.21 more to process nonmachinable packages than to process machinable packages. We reword and translate.

Cost of nonmachinable packages is \$2.21 more than Cost of machinable packages

$$\begin{array}{ccccccc} \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \\ n & = & \$2.21 & + & & m & \end{array}$$

We have $n = \$2.21 + m$. This equation could also be written as $n = m + 2.21$.

82. Observe that in each case the amount received is \$3.00 less than the amount removed from her account. Reword and translate.

Amount received is amount removed minus \$3.00

$$\begin{array}{ccccccc} \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \\ r & = & s & - & & \$3.00 & \end{array}$$
We have $r = s - \$3.00$, or $r = s - 3$.

83. Observe that the number of vehicle miles traveled is 10,000 times the number of drivers. Reword and translate.

Number of Vehicle miles is 10,000 times Number of drivers

$$\begin{array}{ccccccc} \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \\ v & = & 10,000 & \cdot & & d & \end{array}$$
We have $v = 10,000d$.

84. Observe that the depth of the water is one-tenth the depth of the snow. Rerword and translate.

Depth of Water	is	one-tenth	of	Depth of snow
↓	↓	↓	↓	↓
w	$=$	$\frac{1}{10}$	\cdot	s

$w = \frac{1}{10}s$, or, we could write this as

$$w = s \div 10.$$

85. *Thinking and Writing Exercise.* A variable is a letter that is used to stand for any number chosen from a set of numbers. An *algebraic expression* is an expression that consists of variables, constants, operation signs, and/or grouping symbols. A *variable expression* is an algebraic expression that contains a variable. An *equation* is a number sentence with the verb = The symbol '=' is used to indicate that the algebraic expressions on either side of the symbol represent the same quantity.

86. *Thinking and Writing Exercise.* To evaluate an algebraic expression means to find the value of the expression when its variables are given values.

87. *Thinking and Writing Exercise.* No; for a square with side s , the area is given by $A = s \cdot s$. The area of a square with side $2s$ is given by $(2s)(2s) = 4 \cdot s \cdot s = 4A \neq 2A$.

88. *Thinking and Writing Exercise.* Answer may vary.
Juliet was born in 1998. How old will she be in 2006?

89. The sign is a triangle whose area is

$$\frac{1}{2} \cdot b \cdot h, \text{ or } \frac{1}{2}(3\text{ ft})(2.5\text{ ft}) = 3.75\text{ ft}^2$$

The cost is \$120 for each square foot.

Thus, $C = \$120(3.75)$

$$= \$450$$

90. The shaded area is the area of a rectangle with dimensions 20 cm by 10 cm less the area of a triangle with base 20 cm $- 4\text{ cm} - 5\text{ cm}$, or 11 cm, and height 7.5 cm. We perform the computation:

$$\begin{aligned} & (20\text{ cm})(10\text{ cm}) - \frac{1}{2}(11\text{ cm})(7.5) \\ &= 200\text{ cm}^2 - 41.25\text{ cm}^2 \\ &= 158.75\text{ cm}^2, \text{ or } 158.75 \text{ square centimeters} \end{aligned}$$

91. When y is twice x and $x = 6$,

$$y = 2 \cdot 6 = 12$$

$$\begin{aligned} \frac{x+y}{2} &= \frac{6+12}{2} \\ &= \frac{18}{2} = 9 \end{aligned}$$

92. When a is three times b , then b is one-third a , so

$$\begin{aligned} b &= \frac{18}{3} = 6 \\ \frac{a-b}{3} &= \frac{18-6}{3} \\ &= \frac{12}{3} = 4 \end{aligned}$$

93. The next whole number is one more than $w + 3$:

$$w + 3 + 1 = w + 4$$

94. The preceding odd number is 2 less than $d + 2$:

$$d + 2 - 2 = d$$

95. Adding the length of the sides, we have:

$$l + w + l + w, \text{ or } 2l + 2w$$

96. Adding the length of the sides, we have:

$$s + s + s + s, \text{ or } 4s$$

97. Ella's time is 5 more than Kyle's time, or $E = 5 + K$. Kyle's time is 3 more than Ava's time (t), or $K = 3 + t$.

Substituting $3 + t$ for K into $E = 5 + K$

$$\begin{aligned} \text{We have: } 5 + (3 + t), \text{ or } 8 + t, \\ \text{or } t + 8. \end{aligned}$$

Also: Kyle is 3 more than Ava, or $t + 3$ and

Ella is 5 more than Kyle, or $(t + 3) + 5 = t + 8$

98. Ray is currently 2 years older than Monique, or $a + 2$. In 7 years, he will be $a + 2 + 7$, or $a + 9$.

99. *Thinking and Writing Exercise.* Yes; the area of a triangle with base b and height h is given by $A = \frac{1}{2}bh$. The area of a triangle with base b and height $2h$ is given by

$$\frac{1}{2}b(2h) = 2\left(\frac{1}{2}bh\right) = 2A.$$

Exercise Set 1.2

1. commutative
2. associative
3. associative
4. commutative
5. distributive
6. associative
7. associative
8. commutative
9. commutative
10. distributive.

For exercises 11–18, change the order of the *addends*.

11. $x + 7$
12. $2 + a$
13. $3y + x$
14. $3y + 9x$
15. $c + ab$
16. $xy + uv$
17. $5(1 + a)$
18. $9(5 + x)$

For exercises 19–26, change the order of the *factors*.

19. $a \cdot 2$
20. yx
21. ts
22. $x \cdot 4$
23. $5 + ba$
24. $x + y \cdot 3$
25. $(a + 1)5$
26. $(x + 5)9$

For exercises 27–32, regroup the *addends*.

27. $a + (5 + b)$
28. $5 + (m + r)$
29. $(r + t) + 7$
30. $(x + 2) + y$
31. $ab + (c + d)$
32. $m + (np + r)$

For exercises 33–38, regroup the *factors*.

33. $7(mn)$
34. $13(xy)$
35. $(2a)b$
36. $(9r)p$
37. $(3 \cdot 2)(a + b)$
38. $(5x)(2 + y)$

39. $2 + (t + 6) = 2 + (6 + t)$ Commutative law of addition
 $= (2 + 6) + t$ Associative law of addition
 $= 8 + t$ Simplification
 Answers may vary.
40. $(11 + v) + 4 = (v + 11) + 4$ Commutative law of addition
 $= v + (11 + 4)$ Associative law of addition
 $= v + 15$ Simplification
 Answers may vary.
41. $(3a) \cdot 7 = (a \cdot 3) \cdot 7$ Commutative law of multiplication
 $= a(3 \cdot 7)$ Associative law of multiplication
 $= a \cdot 21$ or $21a$ Simplification
 Answers may vary.
42. $5(x \cdot 8) = 5(8x)$ Commutative law of multiplication
 $= (5 \cdot 8)x$ Associative law of multiplication
 $= 40x$ Simplification
 Answers may vary.
43. $(5 + x) + 2$
 $= (x + 5) + 2$ Commutative law
 $= x + (5 + 2)$ Associative law
 $= x + 7$ Simplifying
44. $(2a)4 = 4(2a)$ Commutative law
 $= (4 \cdot 2)a$ Associative law
 $= 8a$ Simplifying
45. $(m \cdot 3)7 = m(3 \cdot 7)$ Associative law
 $= (3 \cdot 7)m$ Commutative law
 $= 21m$ Simplification
46. $4 + (9 + x) = (4 + 9) + x$ Associative law
 $= x + (4 + 9)$ Commutative law
 $= x + 13$ Simplification
- For exercises 47–62, use the distributive law.
47. $4(a + 3) = 4 \cdot a + 4 \cdot 3$
 $= 4a + 12$
48. $3(x + 5) = 3 \cdot x + 3 \cdot 5$
 $= 3x + 15$
49. $6(1 + x) = 6 \cdot 1 + 6 \cdot x$
 $= 6 + 6x$
50. $6(v + 4) = 6 \cdot v + 6 \cdot 4$
 $= 6v + 24$
51. $(n + 5)2 = n \cdot 2 + 5 \cdot 2$
 $= 2n + 10$
52. $(1 + t)3 = 1 \cdot 3 + t \cdot 3$
 $= 3 + 3t$
53. $8(3x + 5y) = 8 \cdot 3x + 8 \cdot 5y$
 $= 24x + 40y$
54. $7(4x + 5y) = 7 \cdot 4x + 7 \cdot 5y$
 $= 28x + 35y$
55. $9(2x + 6) = 9 \cdot 2x + 9 \cdot 6$
 $= 18x + 54$
56. $9(6m + 7) = 9 \cdot 6m + 9 \cdot 7$
 $= 54m + 63$
57. $5(r + 2 + 3t) = 5 \cdot r + 5 \cdot 2 + 5 \cdot 3t$
 $= 5r + 10 + 15t$
58. $4(5x + 8 + 3p) = 4 \cdot 5x + 4 \cdot 8 + 4 \cdot 3p$
 $= 20x + 32 + 12p$
59. $(a + b)2 = a \cdot 2 + b \cdot 2$
 $= 2a + 2b$
60. $(x + 2)7 = x \cdot 7 + 2 \cdot 7$
 $= 7x + 14$
61. $(x + y + 2)5 = x \cdot 5 + y \cdot 5 + 2 \cdot 5$
 $= 5x + 5y + 10$

$$62. (2 + a + b)6 = 2 \cdot 6 + a \cdot 6 + b \cdot 6 \\ = 12 + 6a + 6b$$

For exercises 63–66, the terms are separated by the addition/plus signs.

$$63. x, xyz, 19$$

$$64. 9, 17a, abc$$

$$65. 2a, \frac{a}{b}, 5b$$

$$66. 3xy, 20, \frac{4a}{b}$$

$$67. 2a + 2b = 2 \cdot a + 2 \cdot b \quad \begin{array}{l} \text{The common} \\ \text{factor is 2} \end{array} \\ = 2(a + b) \quad \begin{array}{l} \text{Using the} \\ \text{distributive law} \end{array}$$

$$\text{Check:} \\ 2(a + b) = 2 \cdot a + 2 \cdot b = 2a + 2b$$

$$68. 5y + 5z = 5 \cdot y + 5 \cdot z \quad \begin{array}{l} \text{The common} \\ \text{factor is 5.} \end{array} \\ = 5(y + z) \quad \begin{array}{l} \text{Using the} \\ \text{distributive law} \end{array}$$

$$\text{Check:} \\ 5(y + z) = 5 \cdot y + 5 \cdot z = 5y + 5z$$

$$69. 7 + 7y = 7 \cdot 1 + 7 \cdot y \quad \begin{array}{l} \text{The common} \\ \text{factor is 7} \end{array} \\ = 7(1 + y) \quad \begin{array}{l} \text{Using the} \\ \text{distributive law} \end{array}$$

$$\text{Check:} \\ 7(1 + y) = 7 \cdot 1 + 7y = 7 + 7y$$

$$70. 13 + 13x = 13 \cdot 1 + 13 \cdot x \quad \begin{array}{l} \text{The common} \\ \text{factor is 13.} \end{array} \\ = 13(1 + x) \quad \begin{array}{l} \text{Using the} \\ \text{distributive law} \end{array}$$

$$\text{Check:} \\ 13(1 + x) = 13 \cdot 1 + 13 \cdot x = 13 + 13x$$

$$71. 18x + 3 = 3 \cdot 6x + 3 \cdot 1 \quad \begin{array}{l} \text{The common} \\ \text{factor is 3.} \end{array} \\ = 3(6x + 1) \quad \begin{array}{l} \text{Using the} \\ \text{distributive law} \end{array}$$

Check:

$$3(6x + 1) = 3 \cdot 6x + 3 \cdot 1 = 18x + 3$$

$$72. 20a + 5 = 5 \cdot 4a + 5 \cdot 1 \quad \begin{array}{l} \text{The common} \\ \text{factor is 5.} \end{array} \\ = 5(4a + 1) \quad \begin{array}{l} \text{Using the} \\ \text{distributive law} \end{array}$$

$$\text{Check:} \\ 5(4a + 1) = 5 \cdot 4a + 5 \cdot 1 = 20a + 5$$

$$73. 5x + 10 + 15y = 5 \cdot x + 5 \cdot 2 + 5 \cdot 3y \\ = 5(x + 2 + 3y)$$

$$\text{Check:} \\ 5(x + 2 + 3y) = 5 \cdot x + 5 \cdot 2 + 5 \cdot 3y \\ = 5x + 10 + 15y$$

$$74. 3 + 27b + 6c = 3 \cdot 1 + 3 \cdot 9b + 3 \cdot 2c \\ = 3(1 + 9b + 2c)$$

$$\text{Check:} \\ 3(1 + 9b + 2c) = 3 \cdot 1 + 3 \cdot 9b + 3 \cdot 2c \\ = 3 + 27b + 6c$$

$$75. 12x + 9 = 3 \cdot 4x + 3 \cdot 3 \\ = 3(4x + 3)$$

$$\text{Check:} \\ 3(4x + 3) = 3 \cdot 4x + 3 \cdot 3 \\ = 12x + 9$$

$$76. 25y + 30 = 5 \cdot 5y + 5 \cdot 6 \\ = 5(5y + 6)$$

$$\text{Check:} \\ 5(5y + 6) = 5 \cdot 5y + 5 \cdot 6 \\ = 25y + 30$$

$$77. 3a + 9b = 3 \cdot a + 3 \cdot 3b \\ = 3(a + 3b)$$

$$\text{Check:} \\ 3(a + 3b) = 3a + 3 \cdot 3b \\ = 3a + 9b$$

$$78. 5a + 15b = 5 \cdot a + 5 \cdot 3 \cdot b \\ = 5(a + 3b)$$

$$\text{Check:} \\ 5(a + 3b) = 5 \cdot a + 5 \cdot 3b \\ = 5a + 15b$$

$$79. 44x + 88y + 66z = 22 \cdot 2x + 22 \cdot 4y + 22 \cdot 3z \\ = 22(2x + 4y + 3z)$$

Check:

$$22(2x + 4y + 3z) = 22 \cdot 2x + 22 \cdot 4y + 22 \cdot 3z \\ = 44x + 88y + 66z$$

$$80. 24a + 48b + 60 = 12 \cdot 2a + 12 \cdot 4b + 12 \cdot 5 \\ = 12(2a + 4b + 5)$$

Check:

$$12(2a + 4b + 5) = 12 \cdot 2a + 12 \cdot 4b + 12 \cdot 5 \\ = 24a + 48b + 60$$

$$81. s \text{ and } t$$

$$82. 5 \text{ and } x$$

$$83. 3 \text{ and } (x + y)$$

$$84. (a + b) \text{ and } 6$$

$$85. 7, a, \text{ and } b$$

$$86. m, n, \text{ and } 2$$

$$87. (a - b) \text{ and } (x - y)$$

$$88. (3 - a) \text{ and } (b + c)$$

89. Terms are separated by addition and subtraction signs. A single term may include plus or minus signs only if they are inside parentheses, brackets, or other grouping symbols. Factors are numbers, variables, or expressions that are multiplied together.

$$90. 2(3x + 4y) = 2 \cdot 3x + 2 \cdot 4y \quad \text{Distributive law} \\ = 6x + 8y \quad \text{Simplification}$$

$$91. \text{ Let } k \text{ represent Kylie's salary. Then we have} \\ \frac{1}{2}k, \text{ or } \frac{k}{2}.$$

$$92. \text{ To multiply a sum by a number, put the sum} \\ \text{in parentheses; } 2(m + 7)$$

93. *Thinking and Writing Exercise.* No; in general, when subtracting, the result depends on the order in which the operation is performed.

94. *Thinking and Writing Exercise.* No; in general, when dividing, the result depends on the grouping.

95. The expressions are equivalent by the distributive law.

$$8 + 4(a + b) = 8 + 4 \cdot a + 4 \cdot b \\ = 4 \cdot 2 + 4 \cdot a + 4 \cdot b \\ = 4(2 + a + b)$$

96. The expressions are not equal. Distribution applies only to sums and differences.

$$5(a \cdot b) = 5ab, \text{ but } 5 \cdot a \cdot 5 \cdot b = 5 \cdot 5 \cdot a \cdot b = 25ab.$$

97. The expressions are not equal. For example, let $m = 1$. Then we have

$$7 \div 3 \cdot 1 = \frac{7}{3} \cdot 1 = \frac{7}{3}, \text{ but} \\ 3 \cdot 1 \div 7 = 3 \div 7 = \frac{3}{7}.$$

98. The expressions are equivalent by the commutative law of multiplication and the distributive law.

$$(rt + st)5 = 5(t \cdot r + t \cdot s) \\ = 5 \cdot t(r + s) \\ = 5t(r + s)$$

99. The expressions are not equivalent.

$$5[2(x + 3y)] = 5 \cdot 2(x + 3y) \\ = 10(x + 3y) \\ = 10 \cdot x + 10 \cdot 3y \\ = 10x + 30y \\ = 30y + 10x$$

100. The expressions are equivalent by the commutative law of multiplication and the distributive law.

$$[c(2 + 3b)]5 = 5[c(2 + 3b)] \\ = 5 \cdot c(2 + 3b) \\ = 5c(2 + 3b) \\ = 5c \cdot 2 + 5c \cdot 3b \\ = 10c + 15bc.$$

101. *Thinking and Writing Exercise.*

$$3(2 + x) = 3(2 + 0)$$

$$= 3 \cdot 2 = 6;$$

$$6 + x = 6 + 0 = 6$$

The result indicates that $3(2 + x)$ and $6 + x$ are equivalent when $x = 0$. (By the distributive law, we know they are not equivalent for all values of x .)

102. *Writing Exercise.*

$$15x + 40 = 5(3x + 8)$$

$$15 \cdot 4 + 40 = 60 + 40 = 100$$

$$5(3 \cdot 4 + 8) = 5(12 + 8) = 5 \cdot 20 = 100$$

Although the expressions $15x + 40$ and $5(3x + 8)$ are equivalent for $x = 4$, this result does not guarantee that the factorization is correct for all values of x . (See Exercise 101.)

Exercise Set 1.3

1. b

2. c

3. d

4. a

5. The paired factors of 50 are:

1 · 50, 2 · 25, and 5 · 10

The factors of 50 are:

1, 2, 5, 10, 25, 50.

6. The paired factors of 70 are:

1 · 70, 2 · 35, 5 · 14, and 7 · 10

The factors of 70 are:

1, 2, 5, 7, 10, 14, 35, 70.

7. The paired factors of 42 are:

1 · 42, 2 · 21, 3 · 14, and 6 · 7

The factors of 42 are:

1, 2, 3, 6, 7, 14, 21, 42

8. The paired factors of 60 are:

1 · 60, 2 · 30, 3 · 20, 4 · 15, 5 · 12, and 6 · 10

The factors of 60 are:

1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60

9. Factors of 21 are 1, 3, 7, 21. Composite.

10. Factors of 15 are 1, 3, 5, 15. Composite.

11. The factors of 31 are: 1 and 31. Prime.

12. The factors of 35 are: 1, 5, 7, 35. Composite.

13. The factors of 25 are: 1, 5, 25. Composite.

14. The factors of 37 are: 1 and 37. Prime.

15. The factors of 2 are: 1 and 2. Prime.

16. 1 is the only factor of 1. It is neither prime nor composite. (It is a *unit*.)

17. 0 is neither prime nor composite.

(Note: The number must be a counting number *greater* than 1).

18. The factors of 4 are: 1, 2, 4. Composite.

19. The factors of 40 are: 1, 2, 4, 5, 8, 10, 20, 40. Composite.

20. The factors of 75 are: 1, 3, 5, 15, 25, 75. Composite.

21. $26 = 2 \cdot 13$

22. $15 = 3 \cdot 5$

23. $30 = 2 \cdot 15 = 2 \cdot 3 \cdot 5$

24. $55 = 5 \cdot 11$

25. $27 = 3 \cdot 9 = 3 \cdot 3 \cdot 3$

26. $98 = 2 \cdot 49 = 2 \cdot 7 \cdot 7$

27. $40 = 2 \cdot 20 = 2 \cdot 2 \cdot 10 = 2 \cdot 2 \cdot 2 \cdot 5$

28. $54 = 2 \cdot 27 = 2 \cdot 3 \cdot 9 = 2 \cdot 3 \cdot 3 \cdot 3$

29. 43; Prime

30. $120 = 2 \cdot 60 = 2 \cdot 2 \cdot 30 = 2 \cdot 2 \cdot 2 \cdot 15$
 $= 2 \cdot 2 \cdot 2 \cdot 3 \cdot 5$

31. $210 = 2 \cdot 105 = 2 \cdot 3 \cdot 35 = 2 \cdot 3 \cdot 5 \cdot 7$

32. 79; Prime

33. $115 = 5 \cdot 23$

$$34. 143 = 11 \cdot 13$$

$$\begin{aligned} 35. \frac{14}{21} &= \frac{2 \cdot 7}{3 \cdot 7} && \text{Factoring numerator and denominator} \\ &= \frac{2}{3} \cdot \frac{7}{7} && \text{Rewriting as a product of two fractions} \\ &= \frac{2}{3} \cdot 1 && \frac{7}{7} = 1 \\ &= \frac{2}{3} && \text{Using the identity property of 1} \end{aligned}$$

$$\begin{aligned} 36. \frac{20}{26} &= \frac{2 \cdot 10}{2 \cdot 13} && \text{Factoring numerator and denominator} \\ &= \frac{2}{2} \cdot \frac{10}{13} && \text{Rewriting as a product of two fractions} \\ &= 1 \cdot \frac{10}{13} && \frac{2}{2} = 1 \\ &= \frac{10}{13} && \text{Using the identity property of 1} \end{aligned}$$

$$\begin{aligned} 37. \frac{16}{56} &= \frac{2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2 \cdot 2 \cdot 7} \\ &= \frac{2}{2} \cdot \frac{2}{2} \cdot \frac{2}{2} \cdot \frac{2}{7} = \frac{2}{7} \\ &= 1 \cdot 1 \cdot 1 \cdot \frac{2}{7} = \frac{2}{7} \\ &= \frac{2}{7} \end{aligned}$$

$$\begin{aligned} 38. \frac{72}{27} &= \frac{2 \cdot 2 \cdot 2 \cdot 3 \cdot 3}{3 \cdot 3 \cdot 3} \\ &= \frac{2 \cdot 2 \cdot 2 \cdot \cancel{3} \cdot \cancel{3}}{3 \cdot \cancel{3} \cdot \cancel{3}} \\ &= \frac{8}{3} \end{aligned}$$

$$39. \frac{6}{48} = \frac{\cancel{6}}{\cancel{6} \cdot 8} = \frac{1}{8}$$

$$40. \frac{18}{84} = \frac{\cancel{6} \cdot 3}{\cancel{6} \cdot 14} = \frac{3}{14}$$

$$41. \frac{52}{13} = \frac{1\cancel{3} \cdot 4}{1\cancel{3} \cdot 1} = 4$$

$$42. \frac{132}{11} = \frac{\cancel{11} \cdot 12}{\cancel{11}} = 12$$

$$43. \frac{19}{76} = \frac{\cancel{19}}{4 \cdot \cancel{19}} = \frac{1}{4}$$

$$44. \frac{17}{51} = \frac{\cancel{17}}{3 \cdot \cancel{17}} = \frac{1}{3}$$

$$45. \frac{150}{25} = \frac{6 \cdot \cancel{25}}{\cancel{25}} = 6$$

$$46. \frac{170}{34} = \frac{5 \cdot \cancel{34}}{\cancel{34}} = 5$$

$$47. \frac{42}{50} = \frac{\cancel{2} \cdot 21}{\cancel{2} \cdot 25} = \frac{21}{25}$$

$$48. \frac{75}{80} = \frac{\cancel{5} \cdot 15}{\cancel{5} \cdot 16} = \frac{15}{16}$$

$$49. \frac{120}{82} = \frac{\cancel{2} \cdot 60}{\cancel{2} \cdot 41} = \frac{60}{41}$$

$$50. \frac{75}{45} = \frac{5 \cdot \cancel{15}}{3 \cdot \cancel{15}} = \frac{5}{3}$$

$$51. \frac{210}{98} = \frac{\cancel{2} \cdot 3 \cdot 5 \cdot \cancel{7}}{\cancel{2} \cdot 7 \cdot \cancel{7}} = \frac{15}{7}$$

$$52. \frac{140}{350} = \frac{2 \cdot \cancel{70}}{5 \cdot \cancel{70}} = \frac{2}{5}$$

$$53. \frac{1}{2} \cdot \frac{3}{7} = \frac{1 \cdot 3}{2 \cdot 7} = \frac{3}{14}$$

$$54. \frac{9}{4} \cdot \frac{3}{8} = \frac{9 \cdot 3}{4 \cdot 8} = \frac{27}{32}$$

$$55. \frac{12}{5} \cdot \frac{10}{9} = \frac{12 \cdot 10}{5 \cdot 9} = \frac{\cancel{3} \cdot 4 \cdot \cancel{3} \cdot 2}{\cancel{3} \cdot \cancel{3} \cdot 3} = \frac{4 \cdot 2}{3} = \frac{8}{3}$$

$$56. \frac{11}{12} \cdot \frac{12}{11} = \frac{\cancel{11} \cdot \cancel{12}}{\cancel{12} \cdot \cancel{11}} = 1$$

$$57. \frac{1}{8} + \frac{3}{8} = \frac{1+3}{8} = \frac{4}{8} = \frac{\cancel{4}}{\cancel{4} \cdot 2} = \frac{1}{2}$$

$$58. \frac{1}{2} + \frac{1}{8} = \frac{4}{4} \cdot \frac{1}{2} + \frac{1}{8} \quad \text{Use 8 as the common denominator}$$

$$= \frac{4}{8} + \frac{1}{8} = \frac{4+1}{8}$$

$$= \frac{5}{8}$$

$$59. \frac{4}{9} + \frac{13}{18} = \frac{2}{2} \cdot \frac{4}{9} + \frac{13}{18} \quad \text{Use 18 as the common denominator}$$

$$= \frac{8}{18} + \frac{13}{18} = \frac{21}{18} = \frac{\cancel{3} \cdot 7}{\cancel{3} \cdot 6}$$

$$= \frac{7}{6}$$

$$60. \frac{4}{5} + \frac{8}{15} = \frac{3}{3} \cdot \frac{4}{5} + \frac{8}{15}$$

$$= \frac{12}{15} + \frac{8}{15} = \frac{20}{15}$$

$$= \frac{4 \cdot \cancel{5}}{3 \cdot \cancel{5}} = \frac{4}{3}$$

$$61. \frac{3}{a} \cdot \frac{b}{7} = \frac{3 \cdot b}{a \cdot 7} = \frac{3b}{7a}$$

$$62. \frac{x}{5} \cdot \frac{y}{z} = \frac{x \cdot y}{5 \cdot z} = \frac{xy}{5z}$$

$$63. \frac{4}{a} + \frac{3}{a} = \frac{4+3}{a} = \frac{7}{a}$$

$$64. \frac{7}{a} - \frac{5}{a} = \frac{7-5}{a} = \frac{2}{a}$$

$$65. \frac{3}{10} + \frac{8}{15} = \frac{3}{3} \cdot \frac{3}{10} + \frac{2}{2} \cdot \frac{8}{15} \quad \text{Use 30 as the common denominator}$$

$$= \frac{9}{30} + \frac{16}{30} = \frac{9+16}{30} = \frac{25}{30}$$

$$= \frac{\cancel{5} \cdot 5}{\cancel{5} \cdot 6} = \frac{5}{6}$$

$$66. \frac{7}{8} + \frac{5}{12} = \frac{3}{3} \cdot \frac{7}{8} + \frac{2}{2} \cdot \frac{5}{12} \quad \text{Use 24 as the common denominator}$$

$$= \frac{21}{24} + \frac{10}{24} = \frac{31}{24}$$

$$67. \frac{9}{7} - \frac{2}{7} = \frac{9-2}{7} = \frac{7}{7} = 1$$

$$68. \frac{12}{5} - \frac{2}{5} = \frac{12-2}{5} = \frac{10}{5} = \frac{2 \cdot \cancel{5}}{\cancel{5}} = 2$$

$$69. \frac{13}{18} - \frac{4}{9} = \frac{13}{18} - \frac{2}{2} \cdot \frac{4}{9} \quad \text{Use 18 as the common denominator}$$

$$= \frac{13}{18} - \frac{8}{18}$$

$$= \frac{13-8}{18} = \frac{5}{18}$$

$$70. \frac{13}{15} - \frac{8}{45} = \frac{3}{3} \cdot \frac{13}{15} - \frac{8}{45} \quad \text{Use 45 as the common denominator}$$

$$= \frac{39}{45} - \frac{8}{45}$$

$$= \frac{39-8}{45} = \frac{31}{45}$$

$$71. \frac{20}{30} - \frac{2}{3} = \frac{2 \cdot \cancel{10}}{3 \cdot \cancel{10}} - \frac{2}{3}$$

$$= \frac{2}{3} - \frac{2}{3} = 0$$

$$72. \frac{5}{7} - \frac{5}{21} = \frac{3}{3} \cdot \frac{5}{7} - \frac{5}{21}$$

$$= \frac{15-5}{21}$$

$$= \frac{10}{21}$$

$$73. \frac{7}{6} \div \frac{3}{5} = \frac{7}{6} \cdot \frac{5}{3} \quad \text{Multiply by the reciprocal of the divisor}$$

$$= \frac{7 \cdot 5}{6 \cdot 3}$$

$$= \frac{35}{18}$$

$$74. \frac{7}{5} \div \frac{3}{4} = \frac{7}{5} \cdot \frac{4}{3} \quad \begin{array}{l} \text{Multiply by the reciprocal} \\ \text{of the divisor} \end{array}$$

$$= \frac{7 \cdot 4}{5 \cdot 3}$$

$$= \frac{28}{15}$$

$$75. \frac{8}{9} \div \frac{4}{15} = \frac{8}{9} \cdot \frac{15}{4}$$

$$= \frac{8 \cdot 15}{9 \cdot 4}$$

$$= \frac{2 \cdot \cancel{4} \cdot \cancel{3} \cdot 5}{\cancel{3} \cdot 3 \cdot \cancel{4}}$$

$$= \frac{10}{3}$$

$$76. \frac{1}{8} \div \frac{1}{4} = \frac{1}{8} \cdot \frac{4}{1}$$

$$= \frac{\cancel{4} \cdot 1}{\cancel{4} \cdot 2} = \frac{1}{2}$$

$$77. 12 \div \frac{3}{7} = 12 \cdot \frac{7}{3}$$

$$= \frac{\cancel{3} \cdot 4 \cdot 7}{\cancel{3}} = 28$$

$$78. \frac{10}{9} \div 10 = \frac{10}{9} \cdot \frac{1}{10} = \frac{1}{9}$$

$$79. \frac{7}{13} \div \frac{7}{13} = \frac{7}{13} \cdot \frac{13}{7} = \frac{\cancel{7} \cdot \cancel{13}}{\cancel{13} \cdot \cancel{7}} = 1$$

$$80. \frac{17}{8} \div \frac{5}{6} = \frac{17}{8} \cdot \frac{6}{5} = \frac{17 \cdot \cancel{2} \cdot 3}{\cancel{2} \cdot 4 \cdot 5} = \frac{51}{20}$$

$$81. \frac{\frac{2}{7}}{\frac{5}{3}} = \frac{2}{7} \div \frac{5}{3} = \frac{2}{7} \cdot \frac{3}{5} = \frac{6}{35}$$

$$82. \frac{\frac{3}{8}}{\frac{1}{5}} = \frac{3}{8} \div \frac{1}{5} = \frac{3}{8} \cdot \frac{5}{1} = \frac{15}{8}$$

$$83. \frac{9}{\frac{1}{2}} = 9 \div \frac{1}{2} = 9 \cdot 2 = 18$$

$$84. \frac{\frac{3}{6}}{\frac{7}{7}} = \frac{3}{6} \div 6 = \frac{3}{6} \cdot \frac{1}{6} = \frac{\cancel{3} \cdot 1}{\cancel{3} \cdot 2} = \frac{1}{14}$$

85. *Thinking and Writing Exercise.* There is an infinite number of even numbers. There is an infinite number of whole numbers, and each of these can be multiplied by 2, producing an even number.

86. *Thinking and Writing Exercise.* If the fractions have the same denominators, it would probably be easier to compute their sum than their product.

$$87. 5(x+3) = (x+3)5$$

Commutative Law of Multiplication

$$5(x+3) = 5(3+x)$$

Commutative Law of Addition

$$88. 7 + (a+b) = 7 + (b+a) \text{ or}$$

$$7 + (a+b) = (a+b) + 7$$

89. *Thinking and Writing Exercise.* Bryce is canceling incorrectly. The number 2 is not a common factor of both terms in the numerator, so it cannot be canceled. For example, let $x = 1$. Then $(2+1)/8 = 3/8$ but $(1+1)/4 = 2/4 = 1/2$. The expressions are not equivalent.

90. 0 is not a natural number, and we consider only natural numbers *greater* than 1.

91.

Product	56	63	36	72	140	96	168
Factor	7	7	2	36	14	8	8
Factor	8	9	18	2	10	12	21
Sum	15	16	20	38	24	20	29

92. We need to find the least number that has both 6 and 8 as factors. Starting with 6 we list some numbers with a factor of 6, and starting with 8 we also list some numbers with a factor of 8. Then we find the first number that is on both lists.

6, 12, 18, 24, 30, 36, ...

8, 16, 24, 32, 40, 48, ...

Since 24 is the least number that is on both lists, the carton should be 24 in. long.

$$93. \frac{16 \cdot 9 \cdot 4}{15 \cdot 8 \cdot 12} = \frac{\cancel{4} \cdot \cancel{4} \cdot \cancel{3} \cdot \cancel{3} \cdot \cancel{2} \cdot 2}{\cancel{3} \cdot 5 \cdot \cancel{2} \cdot \cancel{4} \cdot \cancel{3} \cdot \cancel{4}} = \frac{2}{5}$$

$$\text{Similarly: } 4 \frac{1}{2} = \frac{2}{2} \cdot \frac{4}{1} + \frac{1}{2} = \frac{8+1}{2} = \frac{9}{2}$$

$$94. \frac{9 \cdot 8xy}{2xy \cdot 36} = \frac{\cancel{9} \cdot \cancel{2} \cdot \cancel{4} \cdot \cancel{x} \cdot \cancel{y} \cdot 1}{\cancel{2} \cdot \cancel{x} \cdot \cancel{y} \cdot \cancel{4} \cdot \cancel{9}} = 1$$

$$102. \frac{3\frac{5}{7}mn}{2\frac{4}{5}np} = 3\frac{5}{7}mn \div 2\frac{4}{5}np$$

$$= \frac{26mn}{7} \div \frac{14np}{5}$$

$$= \frac{26mn}{7} \cdot \frac{5}{14np}$$

$$= \frac{2 \cdot 13m \cdot \cancel{7} \cdot 5}{7 \cdot 2 \cdot \cancel{7}np}$$

$$= \frac{65m}{49p}$$

$$95. \frac{27pqrs}{9prst} = \frac{3 \cdot \cancel{9} \cdot \cancel{p} \cdot q \cdot \cancel{r} \cdot \cancel{s}}{\cancel{9} \cdot \cancel{p} \cdot \cancel{r} \cdot \cancel{s} \cdot t} = \frac{3q}{t}$$

$$96. \frac{247}{323} = \frac{13 \cdot \cancel{19}}{17 \cdot \cancel{19}} = \frac{13}{17}$$

$$97. \frac{15 \cdot 4xy \cdot 9}{6 \cdot 25x \cdot 15y} = \frac{\cancel{15} \cdot \cancel{2} \cdot 2 \cdot \cancel{x} \cdot \cancel{y} \cdot \cancel{3} \cdot 3}{\cancel{2} \cdot \cancel{3} \cdot 25 \cdot \cancel{x} \cdot \cancel{15} \cdot \cancel{y}} = \frac{6}{25}$$

$$98. \frac{10x \cdot 12 \cdot 25y}{2z \cdot 30x \cdot 20y} = \frac{\cancel{10} \cdot \cancel{x} \cdot \cancel{2} \cdot \cancel{2} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{y}}{\cancel{2} \cdot \cancel{z} \cdot \cancel{3} \cdot \cancel{10} \cdot \cancel{x} \cdot \cancel{2} \cdot \cancel{5} \cdot \cancel{y}} = \frac{5}{2z}$$

$$103. A = lw = \left(\frac{4}{5}\text{m}\right)\left(\frac{7}{9}\text{m}\right) \\ = \left(\frac{4}{5}\right)\left(\frac{7}{9}\right)(\text{m})(\text{m}) \\ = \frac{28}{45}\text{m}^2, \text{ or } \frac{28}{45} \text{ square meters}$$

$$99. \frac{\frac{27ab}{15mn}}{\frac{18bc}{25np}} = \frac{27ab}{15mn} \div \frac{18bc}{25np} = \frac{27ab}{15mn} \cdot \frac{25np}{18bc} = \frac{27ab \cdot 25np}{15mn \cdot 18bc} \\ = \frac{\cancel{3} \cdot \cancel{9} \cdot a \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{p} \cdot p}{\cancel{3} \cdot \cancel{3} \cdot m \cdot \cancel{p} \cdot 2 \cdot \cancel{9} \cdot \cancel{3} \cdot c} = \frac{5ap}{2cm}$$

$$100. \frac{\frac{45xyz}{24ab}}{\frac{30xz}{32ac}} = \frac{45xyz}{24ab} \cdot \frac{32ac}{30xz} \\ = \frac{\cancel{3} \cdot \cancel{15} \cdot \cancel{x} \cdot y \cdot \cancel{z} \cdot \cancel{2} \cdot \cancel{2} \cdot \cancel{3} \cdot a \cdot c}{\cancel{3} \cdot \cancel{3} \cdot \cancel{a} \cdot b \cdot \cancel{2} \cdot \cancel{15} \cdot \cancel{x} \cdot \cancel{z}} \\ = \frac{2cy}{b}$$

$$101. \frac{5\frac{3}{4}rs}{4\frac{1}{2}st} = 5\frac{3}{4}rs \div 4\frac{1}{2}st \\ = \frac{23rs}{4} \div \frac{9st}{2} = \frac{23rs}{4} \cdot \frac{2}{9st} \\ = \frac{23r\cancel{s} \cdot 2}{2 \cdot 2 \cdot 9\cancel{s} \cdot t} = \frac{23r}{18t}$$

$$\text{Note: } 5\frac{3}{4} = 5 + \frac{3}{4} = \frac{4}{4} \cdot \frac{5}{1} + \frac{3}{4} \\ = \frac{20+3}{4} = \frac{23}{4}$$

$$104. A = \frac{1}{2}bh = \frac{1}{2}\left(\frac{10}{7}\text{m}\right)\left(\frac{5}{4}\text{m}\right) \\ = \frac{1}{2}\left(\frac{10}{7}\right)\left(\frac{5}{4}\right)(\text{m})(\text{m}) \\ = \frac{1 \cdot 10 \cdot 5}{2 \cdot 7 \cdot 4}\text{m}^2 \\ = \frac{1 \cdot \cancel{2} \cdot 5 \cdot 5}{\cancel{2} \cdot 7 \cdot 4}\text{m}^2 \\ = \frac{25}{28}\text{m}^2, \text{ or } \frac{25}{28} \text{ square meters}$$

$$105. P = 4s = 4\left(3\frac{5}{9}\text{m}\right) \\ = 4 \cdot \frac{32}{9}\text{m} \\ = \frac{128}{9}\text{m}, \text{ or } 14\frac{2}{9}\text{m}$$

$$\begin{aligned}
 106. \quad P &= 2l + 2w = 2\left(\frac{4}{5}m\right) + 2\left(\frac{7}{9}m\right) \\
 &= \frac{8}{5}m + \frac{14}{9}m \\
 &= \left(\frac{8}{5} + \frac{14}{9}\right)m \\
 &= \left(\frac{8}{5} \cdot \frac{9}{9} + \frac{14}{9} \cdot \frac{5}{5}\right)m \\
 &= \left(\frac{72}{45} + \frac{70}{45}\right)m \\
 &= \frac{142}{45}m, \text{ or } 3\frac{7}{45}m
 \end{aligned}$$

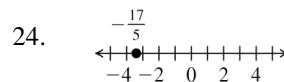
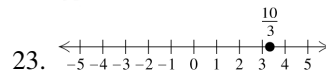
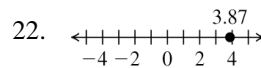
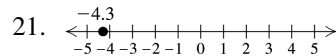
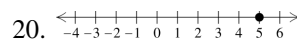
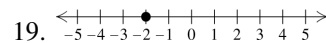
107. The cube has 12 edges, all with length of $2\frac{3}{10}$ cm.

$$\begin{aligned}
 TL &= 12 \cdot 2\frac{3}{10} \\
 &= 12 \cdot \frac{23}{10} = \frac{\cancel{2} \cdot 6 \cdot 23}{\cancel{2} \cdot 5} \\
 &= \frac{138}{5} = 27\frac{3}{5} \text{ cm}
 \end{aligned}$$

Exercise Set 1.4

1. repeating
2. terminating
3. integer
4. whole number
5. rational number
6. irrational number
7. natural number
8. absolute value
9. 100 corresponds to the highest temperature recorded in Alaska. -80 corresponds to the lowest.
10. -250 corresponds to burning 250 calories, and 65 corresponds to consuming 65 calories.

11. -777.68 corresponds to falling 777.68 points, and 936.42 corresponds to gaining 936.42 points.
12. -1340 corresponds to 1340 feet below sea level, and 29,035 corresponds to 29,035 feet above sea level.
13. -12,500 corresponds to taking on a debt of \$12,500, and 5000 corresponds to receiving \$5000 as a scholarship.
14. 20.18 corresponds to the birth rate of 20.18 births per 1000 people, and -8.23 corresponds to 8.23 deaths per 1000 people.
15. 8 corresponds to the 8 yard gain, and -5 corresponds to the 5 yard loss.
16. 1 corresponds to being 1 over par, and -11 corresponds to being 11 under par.
17. -10 corresponds to 10 seconds before liftoff, and 235 corresponds to 235 seconds after liftoff.
18. 750 corresponds to the \$750 deposit, and -125 corresponds to the \$125 withdrawal.



- 25.
- $\frac{7}{8}$
- means
- $7 \div 8$
- , so we divide.

$$\begin{array}{r} 0.875 \\ 8 \overline{)7.000} \\ \underline{64} \\ 60 \\ \underline{56} \\ 40 \\ \underline{40} \\ 0 \end{array}$$

$$\frac{7}{8} = 0.875.$$

- 26.
- $-\frac{1}{8}$
- means
- $-(1 \div 8)$
- , so we divide.

$$\begin{array}{r} 0.125 \\ 8 \overline{)1.000} \\ \underline{8} \\ 20 \\ \underline{16} \\ 40 \\ \underline{40} \\ 0 \end{array}$$

$$-\frac{1}{8} = -0.125.$$

27. We first find decimal notation for

$\frac{3}{4}$. Since $\frac{3}{4}$ means $3 \div 4$, we divide.

$$\begin{array}{r} 0.75 \\ 4 \overline{)3.00} \\ \underline{28} \\ 20 \\ \underline{20} \\ 0 \end{array}$$

$$-\frac{3}{4} = -0.75.$$

- 28.
- $\frac{11}{6}$
- means
- $11 \div 6$
- , so we divide.

$$\begin{array}{r} 1.833\ldots \\ 6 \overline{)11.000} \\ \underline{6} \\ 50 \\ \underline{48} \\ 20 \\ \underline{18} \\ 2 \end{array}$$

$$\frac{11}{6} = 1.8\overline{3}.$$

- 29.
- $-\frac{7}{6}$
- means
- $-7 \div 6$
- , so we divide.

$$\begin{array}{r} 1.166 \\ 6 \overline{)7.000} \\ \underline{6} \\ 10 \\ \underline{6} \\ 40 \\ \underline{36} \\ 40 \\ \underline{36} \\ 4 \end{array}$$

$$-\frac{7}{6} = -1.1\overline{6}.$$

- 30.
- $-\frac{5}{12}$
- means
- $-5 \div 12$
- , so we divide.

$$\begin{array}{r} 0.4166\ldots \\ 12 \overline{)5.0000} \\ \underline{48} \\ 20 \\ \underline{12} \\ 80 \\ \underline{72} \\ 80 \\ \underline{72} \\ 8 \end{array}$$

$$-\frac{5}{12} = -0.41\overline{6}.$$

- 31.
- $\frac{2}{3}$
- means
- $2 \div 3$
- , so we divide.

$$\begin{array}{r} 0.666\ldots \\ 3 \overline{)2.000} \\ \underline{18} \\ 20 \\ \underline{18} \\ 20 \\ \underline{18} \\ 2 \end{array}$$

$$\frac{2}{3} = 0.\overline{6}.$$

- 32.
- $\frac{1}{4}$
- means
- $1 \div 4$
- , so we divide.

$$\begin{array}{r} 0.25 \\ 4 \overline{)1.00} \\ \underline{8} \\ 20 \\ \underline{20} \\ 0 \end{array}$$

$$\frac{1}{4} = 0.25.$$

- 33.
- $-\frac{1}{2}$
- means
- $-(1 \div 2)$
- , so we divide

$$\begin{array}{r} 0.5 \\ 2 \overline{)1.0} \\ \underline{10} \\ 0 \end{array}$$

$$\frac{1}{2} = 0.5, \text{ so } -\frac{1}{2} = -0.5.$$

- 34.
- $-\frac{2}{9}$
- means
- $-2 \div 9$
- , so we divide.

$$\begin{array}{r} 0.2 \\ 9 \overline{)2.00} \\ \underline{18} \\ 2 \end{array}$$

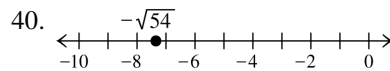
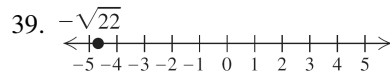
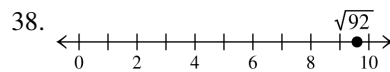
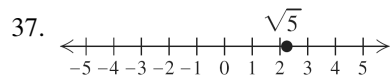
$$-\frac{2}{9} = -0.\overline{2}.$$

35. Since the denominator is 100, we know that
- $\frac{13}{100} = 0.13$
- . We could also divide 13 by 100 to find this result.

- 36.
- $-\frac{7}{20}$
- means
- $-(7 \div 20)$
- , so we divide.

$$\begin{array}{r} 0.35 \\ 20 \overline{)7.00} \\ \underline{60} \\ 100 \\ \underline{100} \\ 0 \end{array}$$

$$-\frac{7}{20} = -0.35.$$



41. $7 > 0$, since 7 is to the right of 0.
 42. $8 > -8$, since 8 is to the right of -8 .
 43. $-6 < 6$, since -6 is to the left of 6.
 44. $0 > -7$, since 0 is to the right of -7 .
 45. $-8 < -5$, since -8 is to the left of -5 .

46. $-4 < -3$, since -4 is to the left of -3 .
 47. $-5 > -11$, since -5 is to the right of -11 .
 48. $-3 > -4$, since -3 is to the right of -4 .
 49. $-12.5 < -9.4$, since -12.5 is to the left of -9.4 .
 50. $-10.3 > -14.5$, since -10.3 is to the right of -14.5 .
 51. $-\frac{5}{12} > -\frac{11}{25}$, since $-\frac{5}{12}$ is to the right of $-\frac{11}{25}$.
 52. $\frac{-14}{17} < \frac{-27}{35}$, since $\frac{-14}{17}$ is to the left of $\frac{-27}{35}$.
 53. $-7 > x$ has the same meaning as $x < -7$.
 54. $a > 9$ has the same meaning as $9 < a$.
 55. $-10 \leq y$ has the same meaning as $y \geq -10$.
 56. $12 \geq t$ has the same meaning as $t \leq 12$.
 57. $-3 \geq -11$ is true.
 58. $5 \leq -5$ is false.
 59. $0 \geq 8$ is false.
 60. $-5 \leq 7$ is true.
 61. $-8 \leq -8$ is true.
 62. $8 \geq 8$ is true.
 63. $|-58| = 58$
 64. $|-47| = 47$
 65. $|5.6| = 5.6$
 66. $|\frac{-2}{5}| = \frac{2}{5}$
 67. $|\sqrt{2}| = \sqrt{2}$
 68. $|-456| = 456$
 69. $|\frac{-9}{7}| = \frac{9}{7}$

70. $|- \sqrt{3}| = \sqrt{3}$

71. $|0| = 0$

72. $|4.3| = 4.3$

73. $|x| = |-8| = 8$

74. $|a| = |-5| = 5$

75. $18, -4.7, 0, -\frac{5}{9}, 2.\overline{16}, -37$

76. 18

77. $18, 0, -37$

78. $\pi, \sqrt{17}$

79. All of them:

$$18, -4.7, 0, -\frac{5}{9}, \pi, \sqrt{17}, 2.\overline{16}, -37$$

80. $18, 0$

81. *Thinking and Writing Exercise.* Yes; every integer can be written as $n/1$, a quotient of the form a/b where $b \neq 0$.82. *Thinking and Writing Exercise.* No; for instance, -2 is an integer and -2 is not a natural number.

83. $3xy = 3 \cdot 2 \cdot 7 = 42$

84. $ab + 5 = 5 + ab$, or
 $ab + 5 = ba + 5$.

85. *Thinking and Writing Exercise.* No;
 $|0| = 0$ which is neither positive nor negative.86. *Thinking and Writing Exercise.* There are infinitely many rational numbers between 0 and 1. Consider rational numbers of the form $\frac{1}{n}$, where n is an integer greater than 1. There are infinitely many integers greater than 1, so there are infinitely many numbers $\frac{1}{n}$, all between 0 and 1. (These numbers are a subset of the rational numbers between 0 and 1.)87. *Thinking and Writing Exercise.* No; every positive number is nonnegative, but zero is nonnegative and zero is not positive.88. List the numbers as they occur on the number line, from left to right: $-17, -12, 5, 13$ 89. List the numbers as they occur on the number line, from left to right: $-23, -17, 0, 4$ 90. $-\frac{2}{3}, \frac{1}{2}, -\frac{3}{4}, -\frac{5}{6}, \frac{3}{8}, \frac{1}{6}$ can be written in decimal notation as $-0.66\overline{6}, 0.5, -0.75, -0.83\overline{3}, 0.375, 0.16\overline{6}$, respectively. Listing from least to greatest (in fractional form), we have $-\frac{5}{6}, -\frac{3}{4}, -\frac{2}{3}, \frac{1}{6}, \frac{3}{8}, \frac{1}{2}$.91. Converting to decimal notation, we can write $\frac{4}{5}, \frac{4}{3}, \frac{4}{8}, \frac{4}{6}, \frac{4}{9}, \frac{4}{2}, -\frac{4}{3}$ as $0.8, 1.3\overline{3}, 0.5, 0.6\overline{6}, 0.4\overline{4}, 2, -1.3\overline{3}$, respectively. List the numbers (in fraction form) as they occur on the number line, from left to right:
 $-\frac{4}{3}, \frac{4}{9}, \frac{4}{8}, \frac{4}{6}, \frac{4}{5}, \frac{4}{3}, \frac{4}{2}$

92. $|-5| = 5$ and $-2 = 2$, so $|-5| > |-2|$.

93. $|4| = 4$ and $|-7| = 7$, so $|4| < |-7|$.

94. $|-8| = 8$ and $|8| = 8$, so $|-8| = |8|$.

95. $|23| = 23$ and $|-23| = 23$, so $|23| = |-23|$.

96. $|x| = 7$

 x represents a number whose distance from 0 is 7. Thus, $x = 7$ or $x = -7$.

97. $|x| < 3$

 x represents an integer whose distance from 0 is less than 3 units. Thus, $x = -2, -1, 0, 1, 2$.

98. $2 < |x| < 5$

 x represents an integer whose distance from 0 is greater than 2 and also less than 5. Thus, $x = -4, -3, 3, 4$

99. $0.1\overline{1} = \frac{0.\overline{3}}{3} = \frac{\frac{1}{3}}{3} = \frac{1}{3} \cdot \frac{1}{3} = \frac{1}{9}$
100. $0.9\overline{9} = 3(0.\overline{3}) = 3 \cdot \frac{1}{3} = \frac{3}{3}$
101. $5.5\overline{5} = 50(0.\overline{1}) = 50 \cdot \frac{1}{9} = \frac{50}{9}$
(See Exercise 99).
102. $7.7\overline{7} = 70(0.\overline{1}) = 70 \cdot \frac{1}{9} = \frac{70}{9}$
(See Exercise 99).
103. $a < 0$
104. $x \leq 0$
105. $|x| \leq 10$
106. $|t| \geq 20$
107. *Thinking and Writing Exercise.* The number entered by hand is an approximation of $\sqrt{2}$ while the value that is squared immediately after being calculated is actually regarded by the calculator as $\sqrt{2}$.
108. *Thinking and Writing Exercise.* Yes. We have three possibilities: a is negative, $a = 0$, or a is positive. We will show an example of each possibility.
- $a = -2$; $\sqrt{(-2)^2} = \sqrt{4} = 2$; $|-2| = 2$
 $a = 0$; $\sqrt{0^2} = \sqrt{0} = 0$; $|0| = 0$
 $a = 7$; $\sqrt{7^2} = \sqrt{49} = 7$; $|7| = 7$.

 Mid-Chapter Review

Guided Solutions

1. $\frac{x-y}{3} = \frac{22-10}{3} = \frac{12}{3} = 4$
2. $40x+8 = 8 \cdot 5x + 8 \cdot 1 = 8(5x+1)$

Mixed Review

1. $x + y = 3 + 12 = 15$

2. $\frac{2a}{5} = \frac{2 \cdot 10}{5} = \frac{20}{5} = 4$

3. $d - 10$

4. Let h be the number of hours worked. Then eight times the number of hours work is: $8h$.

5. Let n be the number of students that originally enrolled in Janine's class. Then reword "five fewer than the number that originally enrolled" as "the number that originally enrolled minus five" and write the equation:

Twenty-seven	is	<div style="display: inline-block; text-align: center;"> The number that originally enrolled </div>	minus	five
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
27	=	n	-	5
$27 = n - 5$				

6. $13 \cdot 8 = 104 \neq 94$, so $t = 8$ is not a solution to $13t = 94$.

7. $7 + 10x = 10x + 7$

8. $3(ab) = (3a)b$

9. $4(2x + 8) = 4 \cdot 2x + 4 \cdot 8 = 8x + 32$

10. $3(2m + 5n + 10) = 3 \cdot 2m + 3 \cdot 5n + 3 \cdot 10$
 $= 6m + 15n + 30$

11. $18x + 9 = 9 \cdot 2x + 9 \cdot 1 = 9(2x + 1)$

12. $8a + 24y + 20 = 4 \cdot 2a + 4 \cdot 6y + 4 \cdot 5$
 $= 4(2a + 6y + 5)$

13. $84 = 2 \cdot 42 = 2 \cdot 2 \cdot 21 = 2 \cdot 2 \cdot 3 \cdot 7$

14. $\frac{48}{40} = \frac{\cancel{8} \cdot 6}{\cancel{8} \cdot 5} = \frac{6}{5}$

15. $135 = 3 \cdot 45 = 3 \cdot 3 \cdot 15 = 3 \cdot 3 \cdot 3 \cdot 5$
 $315 = 3 \cdot 105 = 3 \cdot 3 \cdot 35 = 3 \cdot 3 \cdot 5 \cdot 7$
 $\frac{135}{315} = \frac{\cancel{3} \cdot \cancel{3} \cdot 3 \cdot \cancel{5}}{\cancel{3} \cdot \cancel{3} \cdot \cancel{5} \cdot 7} = \frac{3}{7}$

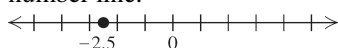
16. $12 = 2 \cdot 6 = 2 \cdot 2 \cdot 3$ and $8 = 2 \cdot 2 \cdot 2$, so
the LCM of 12 and 8 is $2 \cdot 2 \cdot 2 \cdot 3 = 24$.

$$\frac{11}{12} = \frac{11}{12} \cdot \frac{2}{2} = \frac{22}{24} \text{ and } \frac{3}{8} = \frac{3}{8} \cdot \frac{3}{3} = \frac{9}{24}, \text{ so}$$

$$\frac{11}{12} - \frac{3}{8} = \frac{22}{24} - \frac{9}{24} = \frac{22-9}{24} = \frac{13}{24}$$

17. $\frac{8}{15} \div \frac{6}{11} = \frac{8}{15} \cdot \frac{11}{6} = \frac{2 \cdot 2 \cdot \cancel{2}}{3 \cdot 5} \cdot \frac{11}{\cancel{2} \cdot 3} = \frac{44}{45}$

18. -2.5 is 2.5 units to the left of zero on the number line:



19. $-\frac{3}{20} = -(3 \div 20)$ and

$$\begin{array}{r} 3 \div 20 = 20 \overline{)0.15} \\ \underline{20} \\ 100 \\ \underline{100} \\ 0 \end{array}$$

So, $-\frac{3}{20} = -0.15$

20. $-16 \boxed{>} -24$, because -16 is to the right of -24 on the number line.

21. $22 = 2 \cdot 11$ and $15 = 3 \cdot 5$, so the LCM of 22 and 15 is $2 \cdot 3 \cdot 5 \cdot 11 = 330$.

$$-\frac{3}{22} = \frac{-3}{22} \cdot \frac{15}{15} = \frac{-45}{330}$$

$$-\frac{2}{15} = \frac{-2}{15} \cdot \frac{22}{22} = \frac{-44}{330}$$

Therefore $-\frac{3}{22} = \frac{-45}{330} \boxed{<} \frac{-44}{330} = \frac{-2}{15}$

since -45 is to the left of -44 on the number line.

22. $x \geq 9$ is equivalent to $9 \leq x$.

23. -6 is to the left of -5 on the number line, so the statement $-6 \leq -5$ is true.

24. $|-5.6| = 5.6$

25. $|0| = 0$

Exercise Set 1.5

1. f

2. d

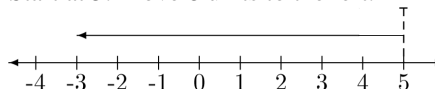
3. e

4. a

5. b

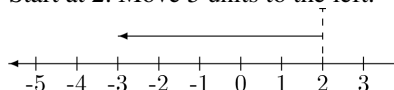
6. c

7. Start at 5. Move 8 units to the left.



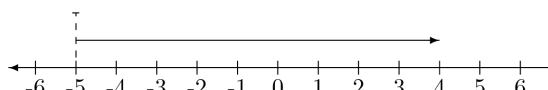
$$5 + (-8) = -3$$

8. Start at 2. Move 5 units to the left.



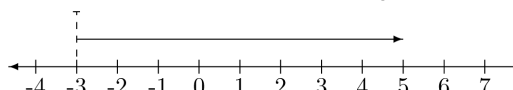
$$2 + (-5) = -3$$

9. Start at -5 . Move 9 units to the right.



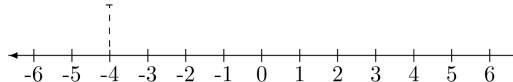
$$-5 + 9 = 4$$

10. Start at -3 . Move 8 units to the right.



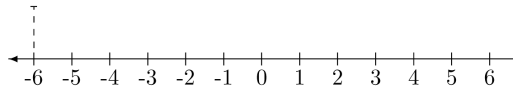
$$-3 + 8 = 5$$

11. Start at -4 . Move 0 units.



$$-4 + 0 = -4$$

12. Start at -6 . Move 0 units.



$$-6 + 0 = -6$$