

Chapter 1

Section 1.2 Practice Exercises

1.
 - a. $5 < 8$ since 5 is to the left of 8 on a number line.
 - b. $6 > 4$ since 6 is to the right of 4 on a number line.
 - c. $16 < 82$ since 16 is to the left of 82 on a number line.
2.
 - a. $9 \geq 3$ is true, since $9 > 3$ is true.
 - b. $3 \geq 8$ is false, since neither $3 > 8$ nor $3 = 8$ is true.
 - c. $25 \leq 25$ is true, since $25 = 25$ is true.
 - d. $4 \leq 14$ is true, since $4 < 14$ is true.
3.
 - a. Three is less than eight is written as $3 < 8$.
 - b. Fifteen is greater than or equal to 9 is written as $15 \geq 9$.
 - c. Six is not equal to seven is written as $6 \neq 7$.
4. The integer -10 represents 10 meters below sea level.
5.
 - a. The natural number is 25.
 - b. The whole number is 25.
 - c. The integers are 25, -15 , -99 .
 - d. The rational numbers are 25, $\frac{7}{3}$, -15 , $-\frac{3}{4}$, -3.7 , 8.8 , -99 .
 - e. The irrational number is $\sqrt{5}$.
 - f. The real numbers are 25, $\frac{7}{3}$, -15 , $-\frac{3}{4}$, $\sqrt{5}$, -3.7 , 8.8 , -99 .
6.
 - a. $0 < 3$ since 0 is to the left of 3 on a number line.
 - b. $15 > -5$ since 15 is to the right of -5 on a number line.

- c. $3 = \frac{12}{4}$ since $\frac{12}{4}$ simplifies to 3.
7.
 - a. $|-8| = 8$ since -8 is 8 units from 0 on a number line.
 - b. $|9| = 9$ since 9 is 9 units from 0 on a number line.
 - c. $|-2.5| = 2.5$ since -2.5 is 2.5 units from 0 on a number line.
 - d. $\left|\frac{5}{11}\right| = \frac{5}{11}$ since $\frac{5}{11}$ is $\frac{5}{11}$ unit from 0 on a number line.
 - e. $|\sqrt{3}| = \sqrt{3}$ since $\sqrt{3}$ is $\sqrt{3}$ units from 0 on a number line.
 8.
 - a. $|8| = |-8|$ since $8 = 8$.
 - b. $|-3| > 0$ since $3 > 0$.
 - c. $|-7| < |-11|$ since $7 < 11$.
 - d. $|3| > |2|$ since $3 > 2$.
 - e. $|0| < |-4|$ since $0 < 4$.
 9.
 - a. The opposite of 5.4 is -5.4 .
 - b. The opposite of $-\frac{3}{5}$ is $\frac{3}{5}$.
 - c. The opposite of 18 is -18 .

Vocabulary, Readiness & Video Check 1.2

1. The whole numbers are $\{0, 1, 2, 3, 4, \dots\}$.
2. The natural numbers are $\{1, 2, 3, 4, 5, \dots\}$.
3. The symbols \neq , \leq , and $>$ are called inequality symbols.
4. The integers are $\{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$.
5. The real numbers are $\{\text{all numbers that correspond to points on a number line}\}$.

6. The rational numbers are $\left\{ \frac{a}{b} \mid a \text{ and } b \text{ are integers, } b \neq 0 \right\}$.
7. The irrational numbers are {nonrational numbers that correspond to points on a number line}.
8. The distance between a number b and 0 on a number line is $|b|$.
9. The opposite of a is $-a$.
10. The absolute value of a number is that number's distance from 0 on a number line.
11. The number $\sqrt{5}$ is an irrational number.
12. The number $\frac{5}{7}$ is a rational number.
13. To form a true statement: $0 < 7$.
14. Five is greater than or equal to four; $5 \geq 4$
15. 0 belongs to the whole numbers, the integers, the rational numbers, and the real numbers; since 0 is a rational number, it cannot also be an irrational number.
16. The absolute value of a real number a , denoted by $|a|$, is the distance between a and 0 on a number line.
17. The absolute value of a number is its *distance* from 0 on a number line, regardless of direction—distance must be positive or zero. The opposite of a number is the *number* that lies the same distance from 0 on the number line as the original number, but on the other side of 0—the opposite of a number can be negative.
10. $0 < 100$ since 0 is to the left of 100 on a number line.
12. $360 \geq 180$ since 360 is to the right of 180 on a number line.
14. $4 \geq 7$ is false, since 4 is to the left of 7 on a number line.
16. $17 > 16$ is true, since 17 is to the right of 16 on a number line.
18. $8 \cdot 8 \leq 8 \cdot 7$ is false, since 64 is to the right of 56 on a number line.
20. $4 < 7$ is true, since 4 is to the left of 7 on a number line.
22. $0 < -15$ is false, since 0 is to the right of -15 on a number line.
24. Fifteen is greater than five is written as $15 > 5$.
26. Negative ten is less than or equal to thirty-seven is written as $-10 \leq 37$.
28. Negative seven is not equal to seven is written as $-7 \neq 7$.
30. The integer 535 represents 535 feet above sea level. The integer -8 represents 8 feet below sea level.
32. The integer $-80,784$ represents 80,784 fewer students.
34. 30 represents an ascent of feet. -50 represents a descent of 50 feet.
36. The number $\frac{1}{4}$ belongs to the sets of rational numbers and real numbers.
38. The number $-\frac{1}{2}$ belongs to the sets of rational numbers and real numbers.
40. The number 5 belongs to the sets of natural numbers, whole numbers, integers, rational numbers, and real numbers.
42. The number $\sqrt{3}$ belongs to the sets of irrational numbers and real numbers.

Exercise Set 1.2

2. $9 < 15$ since 9 is to the left of 15 on a number line.
4. $2.13 > 1.13$ since 2.13 is to the right of 1.13 on a number line.
6. $20 > 0$ since 20 is to the right of 0 on a number line.
8. $-4 > -6$ since -4 is to the right of -6 on a number line.

44. The number $-1\frac{5}{9}$ belongs to the sets of rational numbers and real numbers.
46. False; negative numbers may be irrational.
48. True
50. False; irrational numbers are real.
52. False; $\frac{1}{2}$ is not an integer.
54. False; 0 is a whole number that is not positive.
56. $-200 < -20$ since -200 is to the left of -20 on a number line.
58. $7.1 > -7$ since 7.1 is to the right of -7 on a number line.
60. $\frac{8}{2} = \frac{12}{3}$ since $4 = 4$.
62. $|-20| > -200$ since $20 > -200$.
64. $0 = |0|$ since $0 = 0$.
66. $\left|\frac{2}{5}\right| = \left|-\frac{2}{5}\right|$ since $\frac{2}{5} = \frac{2}{5}$.
68. $-500 < |-50|$ since $-500 < 50$.
70. $|-12| = \frac{24}{2}$ since $12 = \frac{24}{2}$.
72. The opposite of -7.8 is $-(-7.8) = 7.8$.
74. The opposite of $\frac{9}{5}$ is $-\frac{9}{5}$.
76. The opposite of $-\frac{14}{3}$ is $-\left(-\frac{14}{3}\right) = \frac{14}{3}$.
78. The opposite of 10.3 is -10.3 .
80. The 2014 cranberry production in Massachusetts was 206 million pounds, while the 2014 cranberry production in Wisconsin was 539 million pounds.
206 million $<$ 539 million
82. The bars for Oregon and New Jersey are closest in length, so Oregon and New Jersey had the closest cranberry crops in 2014.
84. The tallest bars represent 49 players admitted.
86. Look for the bar with a height less than 30; 1956–1965.
88. answers may vary
90. $0.96 < 0.98$ since 0.96 is to the left of 0.98 on a number line.
92. Spica is dimmer since $0.98 > 0.96$.
94. Regulus is dimmest since 1.35 is to the right of all other numbers listed.
96. $13 \geq -13$ has the same meaning as $-13 \leq 13$.
98. $73 < 75$ has the same meaning as $75 > 73$.
100. $-2 > -4$ has the same meaning as $-4 < -2$.
102. answers may vary

Section 1.3 Practice Exercises

1. a. $1^3 = 1 \cdot 1 \cdot 1 = 1$
b. $5^2 = 5 \cdot 5 = 25$
c. $\left(\frac{1}{10}\right)^2 = \left(\frac{1}{10}\right)\left(\frac{1}{10}\right) = \frac{1}{100}$
d. $9^1 = 9$
e. $\left(\frac{2}{5}\right)^3 = \left(\frac{2}{5}\right)\left(\frac{2}{5}\right)\left(\frac{2}{5}\right) = \frac{8}{125}$
2. a. $6 + 3 \cdot 9 = 6 + 27 = 33$
b. $4^3 \div 8 + 3 = 64 \div 8 + 3 = 8 + 3 = 11$
c. $\left(\frac{2}{3}\right)^2 \cdot |-8| = \frac{4}{9} \cdot 8 = \frac{32}{9}$
d. $\frac{9(14-6)}{|-2|} = \frac{9(8)}{2} = \frac{72}{2} = 36$

$$\text{e. } \frac{7}{4} \cdot \frac{1}{4} - \frac{1}{4} = \frac{7}{16} - \frac{4}{16} = \frac{3}{16}$$

$$3. \frac{6^2 - 5}{3 + |6 - 5| \cdot 8} = \frac{36 - 5}{3 + |1| \cdot 8} = \frac{31}{3 + 8} = \frac{31}{11}$$

$$\begin{aligned} 4. \quad 4[25 - 3(5 + 3)] &= 4[25 - 3(8)] \\ &= 4[25 - 24] \\ &= 4[1] \\ &= 4 \end{aligned}$$

$$5. \frac{36 \div 9 + 5}{5^2 - 3} = \frac{4 + 5}{25 - 3} = \frac{9}{22}$$

$$6. \text{ a. } 2x + y = 2(2) + 5 = 4 + 5 = 9$$

$$\text{b. } \frac{4x}{3y} = \frac{4(2)}{3(5)} = \frac{8}{15}$$

$$\text{c. } \frac{3}{x} + \frac{x}{y} = \frac{3}{2} + \frac{2}{5} = \frac{15}{10} + \frac{4}{10} = \frac{19}{10}$$

$$\text{d. } x^3 + y^2 = 2^3 + 5^2 = 8 + 25 = 33$$

$$7. \quad 9x - 6 = 7x$$

$$9(4) - 6 \stackrel{?}{=} 7(4)$$

$$36 - 6 \stackrel{?}{=} 28$$

$$30 = 28 \quad \text{False}$$

4 is not a solution of $9x - 6 = 7x$.

8. a. Six times a number is $6x$, since $6x$ denotes the product of 6 and x .

b. A number decreased by 8 is $x - 8$ because “decreased by” means subtract.

c. The product of a number and 9 is $x \cdot 9$ or $9x$.

d. Two times a number is $2x$, plus 3 is $2x + 3$.

e. The sum of 7 and a number x is $7 + x$.

9. a. A number x increased by 7 is $x + 7$, so $x + 7 = 13$.

b. Two less than a number x is $x - 2$, so $x - 2 = 11$.

c. Double a number x is $2x$, added to 9 is $2x + 9$, so $2x + 9 \neq 25$.

d. Five times 11 is $5(11)$, so $5(11) \geq x$, where x is an unknown number.

Calculator Explorations

$$1. \quad 5^4 = 625$$

$$2. \quad 7^4 = 2401$$

$$3. \quad 9^5 = 59,049$$

$$4. \quad 8^6 = 262,144$$

$$5. \quad 2(20 - 5) = 30$$

$$6. \quad 3(14 - 7) + 21 = 3(7) + 21 = 21 + 21 = 42$$

$$7. \quad 24(862 - 455) + 89 = 9857$$

$$8. \quad 99 + (401 + 962) = 1462$$

$$9. \quad \frac{4623 + 129}{36 - 34} = 2376$$

$$10. \quad \frac{956 - 452}{89 - 86} = 168$$

Vocabulary, Readiness & Video Check 1.3

1. In the expression 5^2 , the 5 is called the base and the 2 is called the exponent.

2. The symbols $()$, $[]$, and $\{ \}$ are examples of grouping symbols.

3. A symbol that is used to represent a number is called a variable.

4. A collection of numbers, variables, operation symbols, and grouping symbols is called an expression.

5. A mathematical statement that two expressions are equal is called an equation.

6. A value for the variable that makes an equation a true statement is called a solution.

7. Deciding what values of a variable make an equation a true statement is called solving the equation.

8. The order in which we perform operations does matter! We came up with an order of operations to avoid getting more than one answer when evaluating an expression.
9. The replacement value for z is not used because it's not needed—there is no variable z in the given algebraic expression.
10. No; the variable was replaced with 0 in the equation to see if a true statement occurred, and it did not.
11. We translate phrases to mathematical expressions and sentences to mathematical equations.

Exercise Set 1.3

$$2. \quad 2^5 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$$

$$4. \quad 4^4 = 4 \cdot 4 \cdot 4 \cdot 4 = 256$$

$$6. \quad 1^8 = 1 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 1 \cdot 1 = 1$$

$$8. \quad 8^1 = 8$$

$$10. \quad 9^2 = 9 \cdot 9 = 81$$

$$12. \quad \left(\frac{6}{11}\right)^2 = \left(\frac{6}{11}\right)\left(\frac{6}{11}\right) = \frac{6 \cdot 6}{11 \cdot 11} = \frac{36}{121}$$

$$14. \quad \left(\frac{1}{2}\right)^5 = \left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right) \\ = \frac{1 \cdot 1 \cdot 1 \cdot 1 \cdot 1}{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2} \\ = \frac{1}{32}$$

$$16. \quad (1.5)^2 = (1.5)(1.5) = 2.25$$

$$18. \quad (0.03)^3 = (0.03)(0.03)(0.03) = 0.000027$$

$$20. \quad 8 + 5 \cdot 3 = 8 + 15 = 23$$

$$22. \quad 12 \cdot 5 - 3 \cdot 6 = 60 - 18 = 42$$

$$24. \quad 5(6 - 2) = 5(4) = 20$$

$$26. \quad 6 - 2 \cdot 2 + 2^5 = 6 - 2 \cdot 2 + 32 = 6 - 4 + 32 = 34$$

$$28. \quad 2 \cdot 5^2 = 2 \cdot 25 = 50$$

$$30. \quad \frac{3}{4} \cdot \frac{1}{2} + \frac{2}{3} = \frac{3}{8} + \frac{2}{3} = \frac{9}{24} + \frac{16}{24} = \frac{25}{24}$$

$$32. \quad 3[4 + 3(6 - 4)] = 3[4 + 3(2)] \\ = 3[4 + 6] \\ = 3[10] \\ = 30$$

$$34. \quad \frac{4 \cdot 3 + 2}{4 + 3 \cdot 2} = \frac{12 + 2}{4 + 6} = \frac{14}{10} = \frac{7}{5}$$

$$36. \quad \frac{15 - |3 - 1|}{12 - 3 \cdot 2} = \frac{15 - |2|}{12 - 6} = \frac{15 - 2}{6} = \frac{13}{6}$$

$$38. \quad \frac{3 + 6(8 - 5)}{4^2 + 2} = \frac{3 + 6(3)}{4^2 + 2} \\ = \frac{3 + 6(3)}{16 + 2} \\ = \frac{3 + 18}{16 + 2} \\ = \frac{21}{18} \\ = \frac{7}{6}$$

$$40. \quad \frac{16 + |13 - 5| + 4^2}{17 - 5} = \frac{16 + |8| + 4^2}{17 - 5} \\ = \frac{16 + 8 + 4^2}{17 - 5} \\ = \frac{16 + 8 + 16}{17 - 5} \\ = \frac{40}{12} \\ = \frac{4 \cdot 10}{4 \cdot 3} \\ = \frac{10}{3}$$

$$42. \quad 3 + 4[8(5 \cdot 5 - 20) - 39] = 3 + 4[8(25 - 20) - 39] \\ = 3 + 4[8(5) - 39] \\ = 3 + 4[40 - 39] \\ = 3 + 4[1] \\ = 3 + 4 \\ = 7$$

$$\begin{aligned}
 44. \quad \left(\frac{3}{8}\right)^2 + \frac{1}{4} + \frac{1}{8} \cdot \frac{3}{2} &= \frac{9}{64} + \frac{1}{4} + \frac{1}{8} \cdot \frac{3}{2} \\
 &= \frac{9}{64} + \frac{1}{4} + \frac{3}{16} \\
 &= \frac{9}{64} + \frac{16}{64} + \frac{12}{64} \\
 &= \frac{37}{64}
 \end{aligned}$$

$$46. \text{ a. } (1 + 4) \cdot 6 - 3 = 5 \cdot 6 - 3 = 30 - 3 = 27$$

$$\text{b. } 1 + 4 \cdot (6 - 3) = 1 + 4 \cdot 3 = 1 + 12 = 13$$

$$\text{c. } 1 + 4 \cdot 6 - 3 = 1 + 24 - 3 = 22$$

$$\text{d. } (1 + 4) \cdot (6 - 3) = 5 \cdot 3 = 15$$

$$48. \text{ Let } x = 1. \\ 4x = 4(1) = 4$$

$$50. \text{ Let } y = 3 \text{ and } z = 5.$$

$$\frac{y}{2z} = \frac{3}{2(5)} = \frac{3}{10}$$

$$52. \text{ Let } y = 3. \\ 6y - 8 = 6(3) - 8 = 18 - 8 = 10$$

$$54. \text{ Let } y = 3 \text{ and } z = 5. \\ |5z - 2y| = |5(5) - 2(3)| = |25 - 6| = |19| = 19$$

$$56. \text{ Let } x = 1, y = 3, \text{ and } z = 5. \\ yz - x = 3 \cdot 5 - 1 = 15 - 1 = 14$$

$$58. \text{ Let } z = 5. \\ 2z^2 = 2(5)^2 = 2(25) = 50$$

$$60. \text{ Let } x = 12, y = 8, \text{ and } z = 4. \\ \frac{y}{z} + 8x = \frac{8}{4} + 8(12) = 2 + 96 = 98$$

$$62. \text{ Let } x = 12 \text{ and } y = 8. \\ y^2 - 3x + y = (8)^2 - 3(12) + 8 = 64 - 36 + 8 = 36$$

$$64. \text{ Let } x = 12 \text{ and } y = 8. \\ \frac{y^2 + x}{x^2 + 3y} = \frac{(8)^2 + 12}{(12)^2 + 3(8)} = \frac{64 + 12}{144 + 24} = \frac{76}{168} = \frac{19}{42}$$

$$66. \text{ no; answers may vary}$$

$$\begin{aligned}
 68. \text{ Let } x = 6. \\ 2x + 7 &= 3x \\ 2(6) + 7 &\stackrel{?}{=} 3(6) \\ 12 + 7 &\stackrel{?}{=} 18 \\ 19 &= 18, \text{ false} \\ 6 &\text{ is not a solution of the equation.}
 \end{aligned}$$

$$\begin{aligned}
 70. \text{ Let } x = 2. \\ 4x + 2 &= x + 8 \\ 4(2) + 2 &\stackrel{?}{=} 2 + 8 \\ 8 + 2 &\stackrel{?}{=} 10 \\ 10 &= 10, \text{ true} \\ 2 &\text{ is a solution of the equation.}
 \end{aligned}$$

$$\begin{aligned}
 72. \text{ Let } x = 6. \\ 3x - 10 &= 8 \\ 3(6) - 10 &\stackrel{?}{=} 8 \\ 18 - 10 &\stackrel{?}{=} 8 \\ 8 &= 8, \text{ true} \\ 6 &\text{ is a solution of the equation.}
 \end{aligned}$$

$$\begin{aligned}
 74. \text{ Let } x = 10. \\ x + 6 &= x + 6 \\ 10 + 6 &\stackrel{?}{=} 10 + 6 \\ 16 &= 16, \text{ true} \\ 10 &\text{ is a solution of the equation.}
 \end{aligned}$$

$$\begin{aligned}
 76. \text{ Let } x = 1. \\ 4 &= 1 - x \\ 4 &\stackrel{?}{=} 1 - 1 \\ 4 &= 0, \text{ false} \\ 1 &\text{ is not a solution of the equation.}
 \end{aligned}$$

$$78. \text{ A number increased by 9 is written as } x + 9.$$

$$80. \text{ Five decreased by a number is written as } 5 - x.$$

$$82. \text{ The quotient of a number and 9 is written as } \frac{x}{9}.$$

$$84. \text{ Twice a number, decreased by 72 is written as } 2x - 72.$$

$$86. \text{ Four subtracted from eight is equal to two squared is written as } 8 - 4 = 2^2.$$

$$88. \text{ The difference of sixteen and four is greater than ten is written as } 16 - 4 > 10.$$

$$90. \text{ Seven subtracted from a number is 0 is written as } x - 7 = 0.$$

92. 9.1 times a number equals 4 is written as $9.1x = 4$.
94. Eight added to twice a number is 42 is written as $2x + 8 = 42$.
96. To simplify the expression $(1 + 3) \cdot 6$, first add.
98. To simplify the expression $20 - 4 \div 2$, first divide.
100. yes; answers may vary

	Length, l	Width, w	Perimeter of Rectangle: $2l + 2w$	Area of Rectangle: lw
102.	6 in.	1 in.	$2l + 2w$ $= 2(6 \text{ in.}) + 2(1 \text{ in.})$ $= 12 \text{ in.} + 2 \text{ in.}$ $= 14 \text{ in.}$	lw $= (6 \text{ in.})(1 \text{ in.})$ $= 6 \text{ sq in.}$
104.	4.6 in.	2.4 in.	$2l + 2w$ $= 2(4.6 \text{ in.}) + 2(2.4 \text{ in.})$ $= 9.2 \text{ in.} + 4.8 \text{ in.}$ $= 14 \text{ in.}$	lw $= (4.6 \text{ in.})(2.4 \text{ in.})$ $= 11.04 \text{ sq in.}$

106. answers may vary
108. $2 \cdot (5 + 3^2) = 2 \cdot (5 + 9) = 2 \cdot 14 = 28$
110. a. $3x^2 - 26$ is an expression since it does not contain an equal sign.
- b. $3x^2 - 26 = 1$ is an equation since it contains an equal sign.
- c. $2x - 5 = 7x - 5$ is an equation since it contains an equal sign.
- d. $9y + x - 8$ is an expression since it does not contain an equal sign.
- e. $3^2 - 4(5 - 3)$ is an expression since it does not contain an equal sign.
112. answers may vary
114. answers may vary, for example, $2(10 - 7) + 1$: $2(10 - 7) + 1 = 2(3) + 1 = 6 + 1 = 7$
116. Let $h = 5$, $B = 15$, and $b = 7$.
 $A = \frac{1}{2}h(B + b) = \frac{1}{2}(5)(15 + 7) = \frac{1}{2}(5)(22) = 55$
 The area is 55 sq in.
118. Let $P = 650$, $T = 3$, and $I = 126.75$.
 $\frac{I}{PT} = \frac{126.75}{(650)(3)} = \frac{126.75}{1950} = 0.065 = 6.5\%$

Integrated Review

1. $z^2 = 4^2 = 16$
2. $y^3 = 3^3 = 27$

$$3. \frac{4x-z}{2y} = \frac{4(1)-4}{2(3)} = \frac{4-4}{6} = 0$$

$$4. x(y+2z) = 1[3+2(4)] = 1(3+8) = 11$$

$$5. 6+3 \cdot 5 = 6+15 = 21$$

$$6. 4+7 \cdot 2 = 4+14 = 18$$

$$7. \frac{13}{2-2} = \frac{13}{0}, \text{ undefined}$$

$$8. 12^2 - 10^2 = 144 - 100 = 44$$

$$9. 12 - 3^2 = 12 - 9 = 3$$

$$10. 4 + 5(6 - 2) = 4 + 5(4) = 4 + 20 = 24$$

$$\begin{aligned} 11. 9 + 2[(10-8)^2 + (3)^2] &= 9 + 2[(2)^2 + (3)^2] \\ &= 9 + 2[4 + 9] \\ &= 9 + 2[13] \\ &= 9 + 26 \\ &= 35 \end{aligned}$$

$$\begin{aligned} 12. 8 - 6 + [4(2) + 2(5)] &= 8 - 6 + [8 + 10] \\ &= 8 - 6 + 18 \\ &= 2 + 18 \\ &= 20 \end{aligned}$$

13. The opposite of a positive number is a negative number.

14. $-|-8|$ evaluates to a negative number.

15. The absolute value of a negative number is a positive number.

16. The absolute value of zero is 0.

17. The reciprocal of a positive number is a positive number.

18. The opposite of 0 is 0.

19. The absolute value of a positive number is a positive number.

20. The opposite of a negative number is a positive number.

	Number	Opposite	Absolute Value
21.	$\frac{1}{7}$	$-\frac{1}{7}$	$ \frac{1}{7} = \frac{1}{7}$
22.	$-\frac{12}{5}$	$-(-\frac{12}{5}) = \frac{12}{5}$	$ \frac{-12}{5} = \frac{12}{5}$
23.	3	-3	$ 3 = 3$
24.	$-\frac{9}{11}$	$\frac{9}{11}$	$ \frac{-9}{11} = \frac{9}{11}$

Section 1.4 Practice Exercises

1. a. $-6 + (-2) = -(6 + 2) = -8$

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

c. $-4 + 9 = 5$

d. $-3.2 + (-4.9) = -8.1$

e. $-\frac{3}{5} + \frac{2}{3} = -\frac{3}{5} \cdot \frac{3}{3} + \frac{2}{3} \cdot \frac{5}{5} = -\frac{9}{15} + \frac{10}{15} = \frac{1}{15}$

f. $-\frac{5}{11} + \frac{3}{22} = -\frac{5}{11} \cdot \frac{2}{2} + \frac{3}{22} = -\frac{10}{22} + \frac{3}{22} = -\frac{7}{22}$

2. a. $3 - 11 = 3 + (-11) = -8$

b. $-6 - (-3) = -6 + (3) = -3$

c. $-7 - 5 = -7 + (-5) = -12$

d. $4.2 - (-3.5) = 4.2 + 3.5 = 7.7$

e. $-\frac{5}{7} - \frac{1}{3} = -\frac{5 \cdot 3}{7 \cdot 3} - \frac{1 \cdot 7}{3 \cdot 7}$
 $= -\frac{15}{21} + \left(-\frac{7}{21}\right)$
 $= -\frac{22}{21}$

f. $3 - 1.2 = 3 + (-1.2) = 1.8$

g. $2 - 9 = 2 + (-9) = -7$

3. a. $13 + 5 - 6 = 18 - 6 = 12$

b. $-6 - 2 + 4 = -8 + 4 = -4$

4. a. Since the signs of the two numbers are different or unlike, the product is negative.
 $(-5)(3) = -15$

- b. Since the signs of the two numbers are the same, the product is positive.

$$(-7)\left(-\frac{1}{14}\right) = \frac{7}{14} = \frac{1}{2}$$
- c. $5.1(-2) = -10.2$
- d. $14(0) = 0$
- e.
$$\left(-\frac{1}{4}\right)\left(\frac{8}{13}\right) = -\frac{8}{52} = -\frac{2}{13}$$
- f. $6(-1)(-2)(3) = -6(-2)(3) = 12(3) = 36$
- g. $5(-2.3) = -11.5$
5. a. Since the signs are different or unlike, the quotient is negative.

$$\frac{-16}{8} = -2$$
- b. Since the signs are the same, the quotient is positive.

$$\frac{-15}{-3} = 5$$
- c.
$$-\frac{2}{3} \div 4 = -\frac{2}{3} \cdot \frac{1}{4} = -\frac{1}{6}$$
- d.
$$\frac{54}{-9} = -6$$
- e.
$$-\frac{1}{12} \div \left(-\frac{3}{4}\right) = -\frac{1}{12} \cdot -\frac{4}{3} = \frac{1}{9}$$
- f.
$$\frac{0}{-7} = 0$$
6. a. $2^3 = 2 \cdot 2 \cdot 2 = 8$
- b.
$$\left(\frac{1}{3}\right)^2 = \left(\frac{1}{3}\right)\left(\frac{1}{3}\right) = \frac{1}{9}$$
- c. $-12^2 = -(12 \cdot 12) = -144$
- d. $(-12)^2 = (-12)(-12) = 144$
- e. $-4^3 = -(4 \cdot 4 \cdot 4) = -64$
- f. $(-4)^3 = (-4)(-4)(-4) = -64$
7. a. $\sqrt{49} = 7$ since 7 is positive and $7^2 = 49$.
- b. $\sqrt{\frac{1}{16}} = \frac{1}{4}$ since $\left(\frac{1}{4}\right)^2 = \frac{1}{16}$.
- c. $-\sqrt{64} = -8$
- d. $\sqrt{-64}$ is not a real number.
- e. $\sqrt{100} = 10$ since $10^2 = 100$.
8. a. $14 - 3 \cdot 4 = 14 - 12 = 2$
- b. $3(5 - 8)^2 = 3(-3)^2 = 3(9) = 27$
- c.
$$\frac{|-5|^2 + 4}{\sqrt{4} - 3} = \frac{5^2 + 4}{2 - 3} = \frac{25 + 4}{-1} = \frac{29}{-1} = -29$$
9.
$$\begin{aligned} 5 - [(3 - 5) + 6(2 - 4)] &= 5 - [-2 + 6(-2)] \\ &= 5 - [-2 + (-12)] \\ &= 5 - [-14] \\ &= 5 + 14 \\ &= 19 \end{aligned}$$
10.
$$\begin{aligned} \frac{-2\sqrt{12+4} - (-3)^2}{6^2 + |1-9|} &= \frac{-2\sqrt{16} - (-3)^2}{6^2 + |-8|} \\ &= \frac{-2(4) - 9}{36 + 8} \\ &= \frac{-8 - 9}{44} \\ &= -\frac{17}{44} \end{aligned}$$
11. For each expression, replace x with 16 and y with -5.
- a. $2x - 7y = 2(16) - 7(-5) = 32 + 35 = 67$
- b. $-4y^2 = -4(-5)^2 = -4(25) = -100$

$$\begin{aligned}
 \text{c. } \frac{\sqrt{x}}{y} - \frac{y}{x} &= \frac{\sqrt{16}}{-5} - \frac{-5}{16} \\
 &= -\frac{4}{5} + \frac{5}{16} \\
 &= -\frac{4}{5} \cdot \frac{16}{16} + \frac{5}{16} \cdot \frac{5}{5} \\
 &= -\frac{64}{80} + \frac{25}{80} \\
 &= -\frac{39}{80}
 \end{aligned}$$

12. When $x = -5$,
 $\frac{9}{5}x + 32 = \frac{9}{5}(-5) + 32 = -9 + 32 = 23$.
 When $x = 10$,
 $\frac{9}{5}x + 32 = \frac{9}{5}(10) + 32 = 18 + 32 = 50$.
 When $x = 25$,
 $\frac{9}{5}x + 32 = \frac{9}{5}(25) + 32 = 45 + 32 = 77$.

The completed table is

Degrees Celsius	x	-5	10	25
Degrees Fahrenheit	$\frac{9}{5}x + 32$	23	50	77

Vocabulary, Readiness & Video Check 1.4

- $0 \cdot a = \underline{0}$
- $\frac{0}{4}$ simplifies to 0 while $\frac{4}{0}$ is undefined.
- The reciprocal of the nonzero number b is $\frac{1}{b}$.
- The fraction $-\frac{a}{b} = \frac{-a}{b} = \frac{a}{-b}$.
- An exponent is a shorthand notation for repeated multiplication of the same number.
- In $(-5)^2$, the 2 is the exponent and the -5 is the base.
- The opposite of squaring a number is taking the square root of a number.
- Using order of operations, $9 \div 3 \cdot 3 = \underline{9}$.

9. addition

- The signs of the numbers determine the sign of the product or quotient. Same signs mean a positive product or quotient and different signs mean a negative product or quotient.
- The parentheses, or lack of them, determine the base of the expression. In Example 7, -7^2 , the base is 7 and only 7 is squared. In Example 8, $(-7)^2$, the base is -7 and all of -7 is squared.
- the positive or principal square root
- It allows each expression to evaluate to a single number.
- The 2 is part of a multiplication which must happen before addition in the order of operations.

Exercise Set 1.4

- $12 + (-7) = 5$
- $-5 + (-9) = -14$
- $6 + (-4) = 2$
- $-10 + 5 = -5$
- $-7 + (-4) = -11$
- $23 + (-23) = 0$
- $-12 - 8 = -12 + (-8) = -20$
- $8 - 11 = 8 + (-11) = -3$
- $12 - (-5) = 12 + 5 = 17$
- $-4 - (-16) = -4 + 16 = 12$
- $-8.2 - (-6.6) = -8.2 + 6.6 = -1.6$
- $15 - (-1) = 15 + 1 = 16$
- $\frac{7}{10} - \frac{4}{5} = \frac{7}{10} + \left(-\frac{8}{10}\right) = -\frac{1}{10}$
- $-13 - 4 + 9 = -17 + 9 = -8$
- $-\frac{5}{2} - \left(-\frac{2}{3}\right) = -\frac{5}{2} + \frac{2}{3} = -\frac{15}{6} + \frac{4}{6} = -\frac{11}{6}$

32. $-2 - 3 = -2 + (-3) = -5$

34. $-4 - 9 = -4 + (-9) = -13$

36. $11 - (-14) = 11 + 14 = 25$

38. $-3 \cdot 8 = -24$

40. $7(-4) = -28$

42. $-6(-11) = 66$

44. $-5 \cdot 0 = 0$

46. $\frac{-20}{5} = -4$

48. $\frac{-36}{-6} = 6$

50. $\frac{-2}{0}$ is undefined.

52. $5\left(-\frac{1}{50}\right) = -\frac{5}{50} = -\frac{1}{10}$

54. $(-0.9)(-0.5) = 0.45$

56. $22.5 \div (-2.5) = \frac{22.5}{1} \cdot \frac{1}{-2.5} = -9$

58. Multiplying from left to right gives
 $-5(-3)(-2) = 15(-2) = -30.$

60. $(-7)^2 = (-7) \cdot (-7) = 49$

62. $-6^2 = -(6 \cdot 6) = -36$

64. $-2^3 = -(2 \cdot 2 \cdot 2) = -8$

66. $\left(-\frac{1}{2}\right)^4 = \left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right) = \frac{1}{16}$

68. $\sqrt{81} = 9$ since 9 is positive and $9^2 = 81.$

70. $-\sqrt{\frac{4}{25}} = -\frac{2}{5}$ since $\left(\frac{2}{5}\right)^2 = \frac{4}{25}.$

72. $\sqrt{121} = 11$ since $11^2 = 121.$

74. $\sqrt{1} = 1$ since $1^2 = 1.$

76. $\sqrt{-25}$ is not a real number

78. $7(3-8)^2 = 7(-5)^2 = 7(25) = 175$

80. $-5^2 - 2^4 = -25 - 16 = -25 + (-16) = -41$

82. $\frac{4.2 - (-8.2)}{-0.4} = \frac{4.2 + 8.2}{-0.4} = \frac{12.4}{-0.4} = -31$

84. $(-15)^2 - 2^4 = 225 - 16 = 209$

86. $-20 \div 5 \cdot 4 = -4 \cdot 4 = -16$

88. $-10\left(-\frac{2}{5}\right) - 10 = 4 - 10 = -6$

90. $\frac{6 + (-2)^2}{4 - 9} = \frac{6 + 4}{4 - 9} = \frac{10}{-5} = -2$

92. $\frac{-2 - 4^2}{3(-6)} = \frac{-2 - 16}{3(-6)} = \frac{-2 + (-16)}{-18} = \frac{-18}{-18} = 1$

94. $\frac{8 - 3(-2)}{2 - 5(-4)} = \frac{8 - (-6)}{2 - (-20)} = \frac{8 + 6}{2 + 20} = \frac{14}{22} = \frac{7}{11}$

96. $\frac{|-3 + 6| + |-2 + 7|}{|-2 \cdot 2|} = \frac{|3| + |5|}{|-4|} = \frac{3 + 5}{4} = \frac{8}{4} = 2$

98. $\frac{-\sqrt{16} - (6 - 2.4)}{-2} = \frac{-4 - (6 - 2.4)}{-2}$
 $= \frac{-4 - 3.6}{-2}$
 $= \frac{-7.6}{-2}$
 $= 3.8$

100. $\frac{(-2)^4 + 3\sqrt{120 - 20}}{4^3 + |5(-1)|} = \frac{(-2)^4 + 3\sqrt{100}}{4^3 + |-5|}$
 $= \frac{16 + 3(10)}{64 + 5}$
 $= \frac{16 + 30}{64 + 5}$
 $= \frac{46}{69}$
 $= \frac{2}{3}$

102. Let $x = -5$ and $y = -3$.
 $4x + 5y = 4(-5) + 5(-3) = -20 + (-15) = -35$

104. Let $x = -5$ and $y = -3$.
 $x^2 - 2y^2 = (-5)^2 - 2(-3)^2$
 $= 25 - 2(9)$
 $= 25 + (-18)$
 $= 7$

106. Let $x = -5$ and $y = -3$.
 $y^3 + 3x = (-3)^3 + 3(-5) = -27 + (-15) = -42$

108. Let $x = -5$ and $y = -3$.
 $\frac{2y-12}{x-4} = \frac{2(-3)-12}{-5-4} = \frac{-6-12}{-5-4} = \frac{-18}{-9} = 2$

110. Let $x = -5$ and $y = -3$.
 $\frac{4-2x}{y+3} = \frac{4-2(-5)}{-3+3} = \frac{4+10}{0}$ is undefined.

112. Let $x = 9$, $y = -2$.
 $\frac{y}{2x} - \frac{\sqrt{x}}{3y} = \frac{-2}{2(9)} - \frac{\sqrt{9}}{3(-2)}$
 $= \frac{-2}{18} - \frac{3}{-6}$
 $= -\frac{1}{9} + \frac{1}{2}$
 $= -\frac{2}{18} + \frac{9}{18}$
 $= \frac{7}{18}$

114. Let $x = 9$, $y = -2$.
 $\frac{5+2|y-x|}{x+6y} = \frac{5+2|-2-9|}{9+6(-2)}$
 $= \frac{5+2|-11|}{9+(-12)}$
 $= \frac{5+2(11)}{-3}$
 $= \frac{5+22}{-3}$
 $= \frac{27}{-3}$
 $= -9$

116. a. $r = 2$: $\pi r^2 = \pi(2^2) = \pi(4) \approx 12.56$
 $r = 3$: $\pi r^2 = \pi(3^2) = \pi(9) \approx 28.26$
 $r = 7$: $\pi r^2 = \pi(7^2) = \pi(49) \approx 153.86$
 $r = 10$: $\pi r^2 = \pi(10^2) = \pi(100) \approx 314$
The completed table is:

Radius	r	2	3	7	10
Area	πr^2	12.56	28.26	153.86	314

b. Area increases as radius increases; answers may vary.

118. a. $c = -10$:
 $1.8c + 32 = 1.8(-10) + 32 = -18 + 32 = 14$
 $c = 0$: $1.8c + 32 = 1.8(0) + 32 = 0 + 32 = 32$
 $c = 50$:
 $1.8c + 32 = 1.8(50) + 32 = 90 + 32 = 122$
The completed table is:

Degrees Celsius	c	-10	0	50
Degrees Fahrenheit	$1.8c + 32$	14	32	122

b. Degrees Fahrenheit increase as degrees Celsius increase; answers may vary.

120. $\frac{330}{-1} = -330$

The surface temperature of Neptune is -330°F .

122. $x = 90 - 50 = 90 + (-50) = 40$
The complementary angle is 40° .

124. $y = 180 - 105 = 180 + (-105) = 75$
The supplementary angle is 75° .

126. answers may vary

128. $-4 + 14 = 10$

130. $-15 + (-17) = -32$

132. Since b is a negative number, $-b$ is a positive number.

134. Since b is a negative number, $b + b$ is a negative number.

136. True

138. True

140. Not possible to determine whether $t + r$ is positive or negative.

142. Since q is negative, r is negative, and t is positive, then $r(q - t)$ is positive.

Section 1.5 Practice Exercises

1. a. $x \cdot 8 = \underline{8 \cdot x}$
b. $x + 17 = \underline{17 + x}$
2. a. $(2 + 9) + 7 = \underline{2 + (9 + 7)}$
b. $-4 \cdot (2 \cdot 7) = \underline{(-4 \cdot 2) \cdot 7}$
3. a. $(5 + x) + 9 = (x + 5) + 9 = x + (5 + 9) = x + 14$
b. $5(-6x) = [5 \cdot (-6)]x = -30x$
4. a. $5(x - y) = 5(x) - 5(y) = 5x - 5y$
b. $-6(4 + 2t) = -6(4) + (-6)(2t) = -24 - 12t$
c. $2(3x - 4y - z) = 2(3x) + 2(-4y) + 2(-z)$
 $= 6x - 8y - 2z$
d. $(3 - y) \cdot (-1) = 3(-1) + (-y)(-1) = -3 + y$
e. $-(x - 7 + 2s) = (-1)(x - 7 + 2s)$
 $= (-1)x + (-1)(-7) + (-1)(2s)$
 $= -x + 7 - 2s$
f. $\frac{1}{2}(2x + 4) + 9 = \frac{1}{2}(2x) + \frac{1}{2}(4) + 9$
 $= x + 2 + 9$
 $= x + 11$
5. a. $5 \cdot w + 5 \cdot 3 = 5(w + 3)$
b. $9w + 9z = 9 \cdot w + 9 \cdot z = 9(w + z)$
6. a. $(7 \cdot 3x) \cdot 4 = (3x \cdot 7) \cdot 4$; commutative property of multiplication
b. $6 + (3 + y) = (6 + 3) + y$; associative property of addition
c. $8 + (t + 0) = 8 + t$; identity element for addition
d. $-\frac{3}{4} \cdot \left(-\frac{4}{3}\right) = 1$; multiplicative inverse property
e. $(2 + x) + 5 = 5 + (2 + x)$; commutative property of addition
f. $3 + (-3) = 0$; additive inverse property

- g. $(-3b) \cdot 7 = (-3 \cdot 7) \cdot b$; commutative and associative properties of multiplication

Vocabulary, Readiness & Video Check 1.5

1. $x + 5 = 5 + x$ is a true statement by the commutative property of addition.
2. $x \cdot 5 = 5 \cdot x$ is a true statement by the commutative property of multiplication.
3. $3(y + 6) = 3 \cdot y + 3 \cdot 6$ is true by the distributive property.
4. $2 \cdot (x \cdot y) = (2 \cdot x) \cdot y$ is a true statement by the associative property of multiplication.
5. $x + (7 + y) = (x + 7) + y$ is a true statement by the associative property of addition.
6. The numbers $-\frac{2}{3}$ and $-\frac{3}{2}$ are called reciprocals or multiplicative inverses.
7. The numbers $-\frac{2}{3}$ and $\frac{2}{3}$ are called opposites or additive inverses.
8. order; grouping
9. 2 is outside the parentheses, so the point is made that you should only distribute the -9 to the terms within the parentheses and not also to the 2.
10. The identity element for addition is 0 because if we add 0 to any real number, the result is that real number.
The identity element for multiplication is 1 because any real number times 1 gives a result of that original real number.

Exercise Set 1.5

2. $4 + y = y + 4$
4. $-2 \cdot x = x \cdot (-2)$
6. $ab = ba$
8. $19 + 3y = 3y + 19$
10. $3 \cdot (xy) = (3x) \cdot y$
12. $(y + 4) + z = y + (4 + z)$

$$14. (-3y) \cdot z = -3 \cdot (yz)$$

$$16. 6 + (r + s) = (6 + r) + s$$

$$18. (r + 3) + 11 = r + (3 + 11) = r + 14$$

$$20. 2(42x) = (2 \cdot 42)x = 84x$$

$$22. \frac{1}{8}(8z) = \left(\frac{1}{8} \cdot 8\right)z = 1 \cdot z = z$$

$$24. 7 + (x + 4) = 7 + (4 + x) = (7 + 4) + x = 11 + x$$

$$26. -3(12y) = (-3 \cdot 12)y = -36y$$

$$28. \frac{2}{7}\left(\frac{7}{2}r\right) = \left(\frac{2}{7} \cdot \frac{7}{2}\right)r = 1r = r$$

$$30. \frac{7}{9} + \left(\frac{2}{9} + y\right) = \frac{7}{9} + \frac{2}{9} + y \\ = \frac{9}{9} + y \\ = 1 + y$$

$$32. 7(a + b) = 7a + 7b$$

$$34. 11(y - 4) = 11y - 11 \cdot 4 = 11y - 44$$

$$36. 5(7 + 8y) = 5(7) + 5(8y) = 35 + 40y$$

$$38. 3(8x - 1) = 3(8x) - 3(1) = 24x - 3$$

$$40. 2(x + 5) = 2(x) + 2(5) = 2x + 10$$

$$42. -3(z - y) = -3z - (-3)y = -3z + 3y$$

$$44. -5(2r + 11) = -5(2r) + (-5)(11) = -10r - 55$$

$$46. 8(3y + z - 6) = 8(3y) + 8z - 8(6) = 24y + 8z - 48$$

$$48. -4(4 + 2p + 5q) = -4(4) + (-4)(2p) + (-4)(5q) \\ = -16 - 8p - 20q$$

$$50. -(9r + 5) = -1(9r + 5) \\ = -1(9r) + (-1)(5) \\ = -9r - 5$$

$$52. -(q - 2 + 6r) = -1(q - 2 + 6r) \\ = -1q - (-1)(2) + (-1)(6r) \\ = -q + 2 - 6r$$

$$54. \frac{1}{4}(4x - 2) = \frac{1}{4}(4x) - \frac{1}{4}(2) \\ = \left(\frac{1}{4} \cdot 4\right)x - \left(\frac{1}{4} \cdot 2\right) \\ = x - \frac{1}{2}$$

$$56. -\frac{1}{5}(10a - 25b) = -\frac{1}{5}(10a) - \left(-\frac{1}{5}\right)(25b) \\ = \left(-\frac{1}{5} \cdot 10\right)a - \left(-\frac{1}{5} \cdot 25\right)b \\ = -2 \cdot a + 5 \cdot b \\ = -2a + 5b$$

$$58. 10(4s + 6) - 40 = 10(4s) + 10(6) - 40 \\ = 40s + 60 + (-40) \\ = 40s + 20$$

$$60. -11(5x + 3) + 10 = -11(5x) + (-11)(3) + 10 \\ = -55x - 33 + 10 \\ = -55x - 23$$

$$62. -6(2x + 1) - 1 = -6(2x) + (-6)(1) - 1 \\ = -12x + (-6) - 1 \\ = -12x - 7$$

$$64. 14 \cdot z + 14 \cdot 5 = 14(z + 5)$$

$$66. 9a + 9b = 9(a + b)$$

$$68. (-3)a + (-3)b = -3(a + b)$$

$$70. 25x + 25y = 25(x + y)$$

$$72. 4(3 + 8) = 4 \cdot 3 + 4 \cdot 8; \text{ distributive property}$$

$$74. (x + 9) + 3 = (9 + x) + 3; \text{ commutative property of addition}$$

$$76. 1 \cdot 9 = 9; \text{ identity element for multiplication}$$

$$78. 6 \cdot \frac{1}{6} = 1; \text{ multiplicative inverse property}$$

$$80. (a + 9) + 6 = a + (9 + 6); \text{ associative property of addition}$$

$$82. (11 + r) + 8 = (r + 11) + 8; \text{ commutative property of addition}$$

$$84. r + 0 = r; \text{ identity element for addition}$$

	Expression	Opposite	Reciprocal
86.	$-\frac{2}{3}$	$\frac{2}{3}$	$-\frac{3}{2}$
88.	$4y$	$-4y$	$\frac{1}{4y}$
90.	$-7x$	$7x$	$-\frac{1}{7x}$

92. False; the reciprocal of $-\frac{a}{2}$ is $-\frac{2}{a}$.

The opposite of $-\frac{a}{2}$ is $\frac{a}{2}$.

94. “Putting on your shoes” and “putting on your socks” are not commutative, since the order in which they are performed affects the outcome.
96. “Reading the sports section” and “reading the comics section” are commutative, since the order in which they are performed does not affect the outcome.
98. “Baking a cake” and “eating the cake” are not commutative, since the order in which they are performed affects the outcome.
100. “Feeding the dog” and “feeding the cat” are commutative, since the order in which they are performed does not affect the outcome.
102. a. The property illustrated is the associative property of addition since the grouping of addition changed.
- b. The property illustrated is the commutative property of addition since the order in which they are added changed.
- c. The property illustrated is the commutative property of addition since the order in which they are added changed.
104. answers may vary
106. answers may vary

Chapter 1 Vocabulary Check

- The symbols \neq , $<$, and $>$ are called inequality symbols.
- A mathematical statement that two expressions are equal is called an equation.

- The absolute value of a number is the distance between that number and 0 on a number line.
- A symbol used to represent a number is called a variable.
- Two numbers that are the same distance from 0 but lie on opposite sides of 0 are called opposites.
- A solution of an equation is a value for the variable that makes the equation a true statement.
- Two numbers whose product is 1 are called reciprocals.
- In 2^3 , the 2 is called the base and the 3 is called the exponent.
- Parentheses and brackets are examples of grouping symbols.
- A set is a collection of objects.

Chapter 1 Review

- $8 < 10$ since 8 is to the left of 10 on a number line.
- $7 > 2$ since 7 is to the right of 2 on a number line.
- $-4 > -5$ since -4 is to the right of -5 on a number line.
- $\frac{12}{2} > -8$ since $6 > -8$.
- $|-7| < |-8|$ since $7 < 8$.
- $|-9| > -9$ since $9 > -9$.
- $-|-1| = -1$ since $-1 = -1$.
- $|-14| = -(-14)$ since $14 = 14$.
- $1.2 > 1.02$ since 1.2 is to the right of 1.02 on a number line.
- $-\frac{3}{2} < -\frac{3}{4}$ since $-\frac{3}{2}$ is to the left of $-\frac{3}{4}$ on a number line.
- Four is greater than or equal to negative three is written as $4 \geq -3$.

12. Six is not equal to five is written as $6 \neq 5$.
13. 0.03 is less than 0.3 is written as $0.03 < 0.3$.
14. $155 < 400$ or $400 > 155$
15. a. The natural numbers are 1 and 3.
 b. The whole numbers are 0, 1, and 3.
 c. The integers are $-6, 0, 1$, and 3.
 d. The rational numbers are $-6, 0, 1, 1\frac{1}{2}$, 3, and 9.62.
 e. The irrational number is π .
 f. The real numbers are all numbers in the given set.
16. a. The natural numbers are 2 and 5.
 b. The whole numbers are 2 and 5.
 c. The integers are $-3, 2$, and 5.
 d. The rational numbers are $-3, -1.6, 2, 5, \frac{11}{2}$, and 15.1.
 e. The irrational numbers are $\sqrt{5}$ and 2π .
 f. The real numbers are all numbers in the given set.
17. Look for the negative number with the greatest absolute value. The greatest loss was on Friday.
18. Look for the largest positive number. The greatest gain was on Wednesday.
19. The opposite of -9 is $-(-9) = 9$.
20. The opposite of $\frac{2}{3}$ is $-\frac{2}{3}$.
21. The opposite of $|-2|$ is $-|-2| = -2$.
22. The opposite of $-|-7|$ is $-(-|-7|) = -(-7) = 7$.
23. $6 \cdot 3^2 + 2 \cdot 8 = 6 \cdot 9 + 2 \cdot 8 = 54 + 16 = 70$
 The answer is c.
24. $68 - 5 \cdot 2^3 = 68 - 5 \cdot 8 = 68 - 40 = 68 + (-40) = 28$
 The answer is b.
25. $\left(\frac{2}{7}\right)^2 = \frac{2}{7} \cdot \frac{2}{7} = \frac{4}{49}$
26. $\left(\frac{3}{4}\right)^3 = \frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} = \frac{27}{64}$
27. $3(1 + 2 \cdot 5) + 4 = 3(1 + 10) + 4$
 $= 3(11) + 4$
 $= 33 + 4$
 $= 37$
28. $8 + 3(2 \cdot 6 - 1) = 8 + 3(12 - 1)$
 $= 8 + 3(11)$
 $= 8 + 33$
 $= 41$
29. $\frac{4 + |6 - 2| + 8^2}{4 + 6 \cdot 4} = \frac{4 + |4| + 64}{4 + 24}$
 $= \frac{4 + 4 + 64}{4 + 24}$
 $= \frac{72}{28}$
 $= \frac{4 \cdot 18}{4 \cdot 7}$
 $= \frac{18}{7}$
30. $5[3(2 + 5) - 5] = 5[3(7) - 5]$
 $= 5[21 - 5]$
 $= 5[16]$
 $= 80$
31. The difference of twenty and twelve is equal to the product of two and four is written as
 $20 - 12 = 2 \cdot 4$.
32. The quotient of nine and two is greater than negative five is written as $\frac{9}{2} > -5$.
33. Let $x = 6$ and $y = 2$.
 $2x + 3y = 2(6) + 3(2) = 12 + 6 = 18$
34. Let $x = 6$, $y = 2$, and $z = 8$.
 $x(y + 2z) = 6[2 + 2(8)] = 6[2 + 16] = 6[18] = 108$

35. Let
- $x = 6$
- ,
- $y = 2$
- , and
- $z = 8$
- .

$$\frac{x}{y} + \frac{z}{2y} = \frac{6}{2} + \frac{8}{2(2)} = \frac{6}{2} + \frac{8}{4} = 3 + 2 = 5$$

36. Let
- $x = 6$
- and
- $y = 2$
- .

$$\begin{aligned} x^2 - 3y^2 &= (6)^2 - 3(2)^2 \\ &= 36 - 3(4) \\ &= 36 - 12 \\ &= 36 + (-12) \\ &= 24 \end{aligned}$$

37. Replace
- a
- with 37 and
- b
- with 80.

$$\begin{aligned} 180 - a - b &= 180 - 37 - 80 \\ &= 180 + (-37) + (-80) \\ &= 143 + (-80) \\ &= 63 \end{aligned}$$

The measure of the unknown angle is 63° .

38. Replace
- a
- with 93,
- b
- with 80, and
- c
- with 82.

$$\begin{aligned} 360 - a - b - c &= 360 - 93 - 80 - 82 \\ &= 360 + (-93) + (-80) + (-82) \\ &= 267 + (-80) + (-82) \\ &= 187 + (-82) \\ &= 105 \end{aligned}$$

The measure of the unknown angle is 105° .

39. Let
- $x = 3$
- .

$$\begin{aligned} 7x - 3 &= 18 \\ 7(3) - 3 &\stackrel{?}{=} 18 \\ 21 - 3 &\stackrel{?}{=} 18 \\ 18 &= 18, \text{ true} \end{aligned}$$

3 is a solution of the equation.

40. Let
- $x = 1$
- .

$$\begin{aligned} 3x^2 + 4 &= x - 1 \\ 3(1)^2 + 4 &\stackrel{?}{=} 1 - 1 \\ 3 + 4 &\stackrel{?}{=} 0 \\ 7 &= 0, \text{ false} \end{aligned}$$

1 is not a solution of the equation.

- 41.
- $-15 + 4 = -11$

- 42.
- $-6 + (-11) = -17$

43. $\frac{1}{16} + \left(-\frac{1}{4}\right) = \frac{1}{16} + \left(-\frac{1 \cdot 4}{4 \cdot 4}\right)$
 $= \frac{1}{16} + \left(-\frac{4}{16}\right)$
 $= -\frac{3}{16}$

44. $-8 + |-3| = -8 + 3 = -5$

45. $-4.6 + (-9.3) = -13.9$

46. $-2.8 + 6.7 = 3.9$

47. $6 - 20 = 6 + (-20) = -14$

48. $-3.1 - 8.4 = -3.1 + (-8.4) = -11.5$

49. $-6 - (-11) = -6 + 11 = 5$

50. $4 - 15 = 4 + (-15) = -11$

51. $6(-8) = -48$

52. $(-2)(-14) = 28$

53. $\frac{-18}{-6} = 3$

54. $\frac{42}{-3} = -14$

55. $\frac{-6}{0}$ is undefined.

56. $\frac{0}{-2} = 0$

57. $-7x$ or $-7 \cdot x$

58. $\frac{x}{-13}$ or $x \div (-13)$

59. $-20 - x$

60. $-1 + x$

$$\begin{aligned} 61. \quad -4^2 - (-3 + 5) \div (-1) \cdot 2 &= -16 - (2) \div (-1) \cdot 2 \\ &= -16 + 2 \cdot 2 \\ &= -16 + 4 \\ &= -12 \end{aligned}$$

$$\begin{aligned} 62. \quad -5^2 - (2 - 20) \div (-3) \cdot 3 &= -25 - (-18) \div (-3) \cdot 3 \\ &= -25 - 6 \cdot 3 \\ &= -25 - 18 \\ &= -43 \end{aligned}$$

63. $-5 + 7 - 3 - (-10) = 2 - 3 + 10 = -1 + 10 = 9$

$$\begin{aligned}
 64. \quad 8 - (-3) + (-4) + 6 &= 8 + 3 - 4 + 6 \\
 &= 11 - 4 + 6 \\
 &= 7 + 6 \\
 &= 13
 \end{aligned}$$

$$65. \quad 3(4-5)^4 = 3(-1)^4 = 3(1) = 3$$

$$66. \quad 6(7-10)^2 = 6(-3)^2 = 6(9) = 54$$

$$67. \quad -\frac{6}{15} \div \frac{8}{25} = -\frac{6}{15} \cdot \frac{25}{8} = -\frac{150}{120} = -\frac{5}{4}$$

$$68. \quad \frac{4}{9} \div \left(-\frac{8}{45}\right) = \frac{4}{9} \cdot \left(-\frac{45}{8}\right) = -\frac{180}{72} = -\frac{5}{2}$$

$$69. \quad -\frac{3}{8} + 3(2) \div 6 = -\frac{3}{8} + 6 \div 6 = -\frac{3}{8} + 1 = -\frac{3}{8} + \frac{8}{8} = \frac{5}{8}$$

$$\begin{aligned}
 70. \quad 5(-2) - (-3) - \frac{1}{6} &= -10 + 3 - \frac{1}{6} \\
 &= -7 - \frac{1}{6} \\
 &= -\frac{42}{6} - \frac{1}{6} \\
 &= -\frac{43}{6} \\
 &= -7\frac{1}{6}
 \end{aligned}$$

$$\begin{aligned}
 71. \quad |2^3 - 3^2| - |5 - 7| &= |8 - 9| - |-2| \\
 &= |-1| - 2 \\
 &= 1 - 2 \\
 &= -1
 \end{aligned}$$

$$\begin{aligned}
 72. \quad |5^2 - 2^2| + |9 \div (-3)| &= |25 - 4| + |-3| \\
 &= |21| + 3 \\
 &= 21 + 3 \\
 &= 24
 \end{aligned}$$

$$73. \quad (2^3 - 3^2) - (5 - 7) = (8 - 9) - (-2) = -1 + 2 = 1$$

$$\begin{aligned}
 74. \quad (5^2 - 2^4) + [9 \div (-3)] &= (25 - 16) + (-3) \\
 &= 9 + (-3) \\
 &= 6
 \end{aligned}$$

$$\begin{aligned}
 75. \quad \frac{(8-10)^3 - (-4)^2}{2+8(2) \div 4} &= \frac{(-2)^3 - 16}{2+16 \div 4} \\
 &= \frac{-8-16}{2+4} \\
 &= \frac{-24}{6} \\
 &= -4
 \end{aligned}$$

$$\begin{aligned}
 76. \quad \frac{(2+4)^2 + (-1)^5}{12 \div (2 \cdot 3) - 3} &= \frac{(6)^2 + (-1)}{12 \div 6 - 3} \\
 &= \frac{36-1}{2-3} \\
 &= \frac{35}{-1} \\
 &= -35
 \end{aligned}$$

$$77. \quad (4-9) + 4 - 9 = (-5) + 4 - 9 = -1 - 9 = -10$$

$$78. \quad 3 - 7 - (7 - 3) = -4 - (4) = -8$$

$$79. \quad \frac{\sqrt{25}}{4+3 \cdot 7} = \frac{5}{4+21} = \frac{5}{25} = \frac{1}{5}$$

$$80. \quad \frac{\sqrt{4}}{24-8 \cdot 2} = \frac{2}{24-16} = \frac{2}{8} = \frac{1}{4}$$

$$\begin{aligned}
 81. \quad \text{Let } x = 0, y = 3, z = -2. \\
 x^2 - y^2 + z^2 &= (0)^2 - (3)^2 + (-2)^2 \\
 &= 0 - 9 + 4 \\
 &= -5
 \end{aligned}$$

$$\begin{aligned}
 82. \quad \text{Let } x = 0, y = 3, z = -2. \\
 \frac{5x+z}{2y} &= \frac{5(0)+(-2)}{2(3)} = \frac{0-2}{6} = \frac{-2}{6} = -\frac{1}{3}
 \end{aligned}$$

$$\begin{aligned}
 83. \quad \text{Let } y = 3, z = -2. \\
 \frac{-7y-3z}{-3} &= \frac{-7(3)-3(-2)}{-3} = \frac{-21+6}{-3} = \frac{-15}{-3} = 5
 \end{aligned}$$

$$\begin{aligned}
 84. \quad \text{Let } x = 0, y = 3, z = -2. \\
 (x-y+z)^2 &= (0-3+(-2))^2 \\
 &= (-3-2)^2 \\
 &= (-5)^2 \\
 &= 25
 \end{aligned}$$

$$\begin{aligned}
 85. \quad \text{When } r = 1, 2\pi r &= 2\pi(1) \approx 2(3.14) = 6.28. \\
 \text{When } r = 10, \\
 2\pi r &= 2\pi(10) \approx 20(3.14) = 62.8.
 \end{aligned}$$

When $r = 100$,
 $2\pi r = 2\pi(100) \approx 200(3.14) = 628$.

r	1	10	100
$2\pi r$	6.28	62.8	628

86. As the radius increases, the circumference increases.
87. $-6 + 5 = 5 + (-6)$; commutative property of addition
88. $6 \cdot 1 = 6$; identity element for multiplication
89. $3(8 - 5) = 3 \cdot 8 - 3 \cdot 5$; distributive property
90. $4 + (-4) = 0$; additive inverse property
91. $2 + (3 + 9) = (2 + 3) + 9$; associative property of addition
92. $2 \cdot 8 = 8 \cdot 2$; commutative property of multiplication
93. $6(8 + 5) = 6 \cdot 8 + 6 \cdot 5$; distributive property
94. $(3 \cdot 8) \cdot 4 = 3 \cdot (8 \cdot 4)$; associative property of multiplication
95. $4 \cdot \frac{1}{4} = 1$; multiplicative inverse property
96. $8 + 0 = 8$; identity element for addition
97. $5(y - 2) = 5(y) + 5(-2) = 5y - 10$
98. $-3(z + y) = -3(z) + (-3)(y) = -3z - 3y$
99. $-(7 - x + 4z) = (-1)(7) + (-1)(-x) + (-1)(4z)$
 $= -7 + x - 4z$
100. $\frac{1}{2}(6z - 10) = \frac{1}{2}(6z) + \frac{1}{2}(-10) = 3z - 5$
101. $-4(3x + 5) - 7 = -4(3x) + (-4)(5) - 7$
 $= -12x - 20 - 7$
 $= -12x - 27$
102. $-8(2y + 9) - 1 = -8(2y) + (-8)(9) - 1$
 $= -16y - 72 - 1$
 $= -16y - 73$
103. $-|-11| < |11.4|$ since $-|-11| = -11$ and $|11.4| = 11.4$.
104. $-1\frac{1}{2} > -2\frac{1}{2}$ since $-1\frac{1}{2}$ is to the right of $-2\frac{1}{2}$ on a number line.
105. $-7.2 + (-8.1) = -15.3$
106. $14 - 20 = 14 + (-20) = -6$
107. $4(-20) = -80$
108. $\frac{-20}{4} = -5$
109. $-\frac{4}{5}\left(\frac{5}{16}\right) = -\frac{4}{16} = -\frac{1}{4}$
110. $-0.5(-0.3) = 0.15$
111. $8 \div 2 \cdot 4 = 4 \cdot 4 = 16$
112. $(-2)^4 = (-2)(-2)(-2)(-2) = 16$
113. $\frac{-3 - 2(-9)}{-15 - 3(-4)} = \frac{-3 + 18}{-15 + 12} = \frac{15}{-3} = -5$
114. $5 + 2[(7 - 5)^2 + (1 - 3)] = 5 + 2[2^2 + (-2)]$
 $= 5 + 2[4 + (-2)]$
 $= 5 + 2[2]$
 $= 5 + 4$
 $= 9$
115. $-\frac{5}{8} \div \frac{3}{4} = -\frac{5}{8} \cdot \frac{4}{3} = -\frac{20}{24} = -\frac{5}{6}$
116. $\frac{-15 + (-4)^2 + |-9|}{10 - 2 \cdot 5} = \frac{-15 + 16 + 9}{10 - 10} = \frac{1 + 9}{0}$ is undefined.
117. The opposite of $-\frac{3}{4}$ is $\frac{3}{4}$.
The reciprocal of $-\frac{3}{4}$ is $-\frac{4}{3}$.
118. If the opposite of the number is -5 , then the number is $-(-5) = 5$. The reciprocal of 5 is $\frac{1}{5}$.

	Year	Increase in Life Expectancy (in years) from 10 Years Earlier
119.	1964	$73.3 - 71.1 = 2.2$
120.	1974	$75.9 - 73.3 = 2.6$
121.	1984	$78.2 - 75.9 = 2.3$
122.	1994	$79.0 - 78.2 = 0.8$
123.	2004	$80.4 - 79.0 = 1.4$
124.	2014	$81.2 - 80.4 = 0.8$

Chapter 1 Getting Ready for the Test

- For $-5 + (-3)$, the operation is addition; A.
- For $-5(-3)$, the operation is multiplication; C.
- $6x + 2 + 4x - 10$ is an expression since it does not contain an equal sign; B.
- $6x + 2 = 4x - 10$ is an equation since it contains an equal sign; A.
- $-2(x - 1) = 12$ is an equation since it contains an equal sign; A.
- $-7\left(x + \frac{1}{2}\right) - 22$ is an expression since it does not contain an equal sign; B.
- Since the sum of two numbers with the same sign has the sign common to the two numbers and both a and b are negative numbers, $a + b$ is a negative number; B.
- Since the product of two numbers with the same sign is positive and both a and b are negative numbers, $a \cdot b$ is a positive number; A.
- Since the quotient of two numbers with the same sign is positive and both a and b are negative, $\frac{a}{b}$ is a positive number; A.
- Since 0 added to or subtracted from any number does not change the number and a is a negative number, $a - 0 = a$ is a negative number; B.
- Since the product of 0 and any number is 0, $0 \cdot b$ is 0; C.
- $a - b = a + (-b)$
Since b is a negative number, $-b$ is a positive number and $a - b = a + (-b)$ is the sum of two numbers with different signs. The sum will have the sign of the number with the larger absolute value. Since we do not know whether $|a|$ or $|-b| = |b|$ is larger, it is not possible to determine whether $a - b$ is positive or negative; D.
- Since 0 added to any number does not change the number and b is a negative number, $0 + b$ is a negative number; B.
- Since 0 divided by any nonzero number is 0 and a is not 0, $\frac{0}{a}$ is 0; C.
- $\frac{1}{5}$ is the reciprocal of 5; B.
- $3 + 2(-8)$ is an expression which can be evaluated or simplified; C.
- 2^3 is an expression which can be evaluated or simplified; C.
- 7 is the opposite of -7 ; A.
- $\sqrt{5}$ is an irrational number; choice C.
- $\frac{7}{8}$ is a rational number; choice B.
- $0 = \frac{0}{1}$ is a whole number and also a rational number; choices B and D.
- $-12 = \frac{-12}{1}$ is a negative integer and also a rational number; choices A and B.

Chapter 1 Test

- The absolute value of negative seven is greater than five is written as $|-7| > 5$.
- The sum of nine and five is greater than or equal to four is written as $9 + 5 \geq 4$.
- $-13 + 8 = -5$
- $-13 - (-2) = -13 + 2 = -11$

5. $12 \div 4 \cdot 3 - 6 \cdot 2 = 3 \cdot 3 - 6 \cdot 2 = 9 - 12 = -3$
6. $(13)(-3) = -39$
7. $(-6)(-2) = 12$
8. $\frac{|-16|}{-8} = \frac{16}{-8} = -2$
9. $\frac{-8}{0}$ is undefined.
10. $\frac{|-6|+2}{5-6} = \frac{6+2}{5+(-6)} = \frac{8}{-1} = -8$
11. $5 - 12 \div 3(2) = 5 - 4(2) = 5 - 8 = -3$
12. $5^2 - 3^4 = 25 - 81 = -56$
13. $(4-9)^3 - |-4-6|^2 = (-5)^3 - |-10|^2$
 $= -125 - 10^2$
 $= -125 - 100$
 $= -225$
14. $3(-4)^2 - 80 = 3(16) - 80 = 48 + (-80) = -32$
15. $6[5+2(3-8)-3] = 6\{5+2[3+(-8)]+(-3)\}$
 $= 6\{5+2[-5]+(-3)\}$
 $= 6\{5+(-10)+(-3)\}$
 $= 6\{-5+(-3)\}$
 $= 6\{-8\}$
 $= -48$
16. $\frac{-12+3 \cdot 8}{4} = \frac{-12+24}{4} = \frac{12}{4} = 3$
17. $\frac{(4-\sqrt{16})-(-7-20)}{-2(1-4)^2} = \frac{(4-4)-(-27)}{-2(-3)^2}$
 $= \frac{0+27}{-2(9)}$
 $= \frac{27}{-18}$
 $= -\frac{3}{2}$
18. $-3 > -7$ since -3 is to the right of -7 on a number line.
19. $4 > -8$ since 4 is to the right of -8 on a number line.
20. $2 < |-3|$ since $2 < 3$.
21. $|-2| = -1 - (-3)$ since $|-2| = 2$ and $-1 - (-3) = -1 + 3 = 2$.
22. $2221 < 10,993$
23. a. The natural numbers are 1 and 7.
b. The whole numbers are 0, 1 and 7.
c. The integers are $-5, -1, 0, 1$, and 7.
d. The rational numbers are $-5, -1, 0, \frac{1}{4}, 1, 7$, and 11.6.
e. The irrational numbers are $\sqrt{7}$ and 3π .
f. The real numbers are all numbers in the given set.
24. Let $x = 6$ and $y = -2$.
 $x^2 + y^2 = (6)^2 + (-2)^2 = 36 + 4 = 40$
25. Let $x = 6, y = -2$ and $z = -3$.
 $x + yz = 6 + (-2)(-3) = 6 + 6 = 12$
26. Let $x = 6$ and $y = -2$.
 $2 + 3x - y = 2 + 3(6) - (-2)$
 $= 2 + 18 + 2$
 $= 20 + 2$
 $= 22$
27. Let $x = 6, y = -2$ and $z = -3$.
 $\frac{y+z-1}{x} = \frac{-2+(-3)-1}{6} = \frac{-5+(-1)}{6} = \frac{-6}{6} = -1$
28. $8 + (9 + 3) = (8 + 9) + 3$; associative property of addition
29. $6 \cdot 8 = 8 \cdot 6$; commutative property of multiplication
30. $-6(2 + 4) = -6 \cdot 2 + (-6) \cdot 4$; distributive property
31. $\frac{1}{6}(6) = 1$; multiplicative inverse property
32. The opposite of -9 is $-(-9) = 9$.

33. The reciprocal of $-\frac{1}{3}$ is -3 .
34. Look for the negative number that has the greatest absolute value. The second down had the greatest loss of yardage.
35. Gains: 5, 29
Losses: -10 , -2
Total gain or loss $= 5 + (-10) + (-2) + 29$
 $= (-5) + (-2) + 29$
 $= -7 + 29$
 $= 22$ yards gained
Yes, they scored a touchdown.
36. Since $-14 + 31 = 17$, the temperature at noon was 17° .
37. $356 + 460 + (-166) = 816 + (-166) = 650$
The net income was \$650 million.
38. Change in value per share $= -1.50$
Change in total value $= 280(-1.50) = -420$
She had a total loss of \$420.