

Chapter 1

Section 1.2 Practice Exercises

1. $\{x|x \text{ is a whole number between 0 and 4}\}$
 $= \{1, 2, 3\}$
2. $\{x|x \text{ is a natural number greater than 80}\}$
 $= \{81, 82, 83, \dots\}$
3. Since 0 is not a natural number the statement is false.
4. Since 9 is not an element of $\{4, 6, 8, 10\}$ the statement is true.
5. True; every whole number is a real number.
6. True; every integer is a rational number.
7. False; $\sqrt{3}$ is an irrational number.
8. Seventeen times a number is written as $17 \cdot x$ or $17x$.
9. Five more than six times a number is written as $6x + 5$.
10. The quotient of six and a number is written as $\frac{6}{x}$
or $6 \div x$.
11. One-fourth subtracted from three times a number is written as $3x - \frac{1}{4}$.
12. Eleven less than a number is written as $x - 11$.
13. Three times the difference of a number and ten is written as $3(x - 10)$.

Vocabulary, Readiness & Video Check 1.2

1. Letters that represent numbers are called variables.
2. Finding the value of an expression means evaluating the expression.
3. A set that contains no elements is called the empty set.
4. An expression is formed by numbers and variables connected by operations such as addition.

5. The natural numbers are $\{1, 2, 3, \dots\}$.
6. The whole numbers are $\{0, 1, 2, 3, \dots\}$.
7. The integers are $\{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$.
8. The number $\sqrt{5}$ is an irrational number.
9. The number $\frac{5}{7}$ is a rational number.
10. A set is a collection of objects.
11. When the elements of a set are listed such as $\{1, 3, 5\}$, the set is written in roster form.
12. When the elements of a set are described but not listed, such as $\{x|x \text{ is an odd number between 1 and 5}\}$, the set is written in set-builder notation.
13. Every real number is either a rational number or an irrational number. There are no numbers that are both rational and irrational.
14. Order is important in subtraction, so we must read the phrase carefully to determine the order of subtraction in our algebraic expression.

Exercise Set 1.2

2. $\{x|x \text{ is a natural number greater than 6}\}$
 $= \{7, 8, 9, \dots\}$
4. $\{x|x \text{ is an odd natural number}\} = \{1, 3, 5, \dots\}$
6. $\{x|x \text{ is a natural number less than 1}\} = \{ \}$ or \emptyset
8. $\{x|x \text{ is an odd whole number less than 9}\}$
 $= \{1, 3, 5, 7\}$
10. The integers in the set are 3, 0, $\sqrt{36}$, and -134 .
12. The rational numbers in the set are 3, 0, $\sqrt{36}$, $\frac{2}{5}$, and -134 .
14. The real numbers in the set are 3, 0, $\sqrt{7}$, $\sqrt{36}$, $\frac{2}{5}$, and -134 .
16. $-6 \notin \{2, 4, 6, \dots\}$

18. $12 \in \{1, 2, 3, \dots\}$
20. $\frac{1}{2} \notin \{x|x \text{ is an irrational number}\}$
22. Since the set of irrational numbers is contained in the set of real numbers, the statement is true.
24. Since real numbers can be whole numbers, the statement is true.
26. Since $\sqrt{2}$ is an irrational number but not a rational number, the statement is false.
28. Since $-\frac{4}{5}$ is a rational number and every rational number is a real number, the statement is true.
30. Since 0 is a whole number, the statement is true.
32. Since $-\frac{7}{11}$ is a rational number, the statement is false.
34. Since there are no numbers that are both rational and irrational, the statement is true.
36. Since every integer is a real number, the statement is true.
38. Since not all real numbers are integers, the statement is false.
40. Six times a number is written as $6 \cdot x$ or $6x$.
42. A number minus seven is written as $x - 7$.
44. The difference of twenty-five and a number is written as $25 - x$.
46. The quotient of a number and thirteen is written as $\frac{x}{13}$ or $x \div 13$.
48. Seventeen subtracted from a number is written as $x - 17$.
50. Fifteen and seven-tenths plus a number is written as $15.7 + x$ or $15\frac{7}{10} + x$.
52. Two and three-fourths less than a number is written as $x - 2\frac{3}{4}$.
54. Nine minus a number is written as $9 - x$.
56. Nine divided by a number is written as $\frac{9}{x}$ or $9 \div x$.
58. One more than six times a number is written as $6x + 1$.
60. Four subtracted from three times a number is written as $3x - 4$.
62. Three less than twice a number is written as $2x - 3$.
64. Four minus three times a number is written as $4 - 3x$.
66. The quotient of four and the sum of a number and one is written as $\frac{4}{x+1}$.
68. Eight times the difference of a number and nine is written as $8(x - 9)$.
70. answers may vary
72. answers may vary
74. answers may vary
- | | Year | Increase in Life Expectancy
(in years) |
|-----|------|---|
| 76. | 1970 | $70.8 - 69.7 = 1.1$ |
| 78. | 1990 | $75.1 - 73.7 = 1.4$ |
| 80. | 2010 | $78.7 - 76.8 = 1.9$ |
82. answers may vary

Section 1.3 Practice Exercises

1. The difference of x and 7 is 45 is written as $x - 7 = 45$.
2. The product of 5 and x amounts to the sum of x and 14 is written as $5x = x + 14$.

3. The quotient of y and 23 is the same as 20 subtracted from y is written as $\frac{y}{23} = y - 20$.
4. 7 is to the right of -7 on a number line so $7 > -7$.
5. -1 is to the left of 11 on a number line so $-1 < 11$.
6. -10 is to the right of -12 on a number line so $-10 > -12$.
7. -3.25 is to the left of -3.025 on a number line so $-3.25 < -3.025$.
8. The true statement is $7.206 = 7.2060$.
9. 18.6 is to the right of -14.2 on a number line so $18.6 > -14.2$.
10. The denominators are the same, so $\frac{4}{7} < \frac{5}{7}$ since $4 < 5$.
11. By dividing, we see that $\frac{3}{8} = 0.375$ and $\frac{1}{3} = 0.333\dots$. Thus $\frac{3}{8} > \frac{1}{3}$ since $0.375 > 0.333\dots$.
12. True, since $-11 < 16$ is true.
13. True, since $-7 = -7$ is true.
14. True, since $-7 = -7$ is true.
15. False, since neither $-25 < -30$ nor $-25 = -30$ is true.
16. The opposite of 7 is -7 .
17. The opposite of $\frac{2}{13}$ is $-\frac{2}{13}$.
18. The opposite of $-\frac{5}{7}$ is $-\left(-\frac{5}{7}\right)$ or $\frac{5}{7}$.
19. The opposite of -4.7 is $-(-4.7)$ or 4.7 .
20. The reciprocal of 13 is $\frac{1}{13}$.
21. The reciprocal of -5 is $-\frac{1}{5}$.
22. The reciprocal of $\frac{2}{3}$ is $\frac{3}{2}$ since $\frac{2}{3} \cdot \frac{3}{2} = 1$.
23. By the commutative property of addition $9 + 4x = 4x + 9$.
24. By the associative property of multiplication $5 \cdot (6x) = (5 \cdot 6)x = 30x$.
25. $7(4x - y) = 7 \cdot 4x - 7 \cdot y = 28x - 7y$
26. $8(3 + x) = 8 \cdot 3 + 8 \cdot x = 24 + 8x$
27. $5x(y - 4) = 5x \cdot y - 5x \cdot 4 = 5xy - 20x$

Vocabulary, Readiness & Video Check 1.3

	Symbol	Meaning
1.	$<$	is less than
2.	$>$	is greater than
3.	\neq	is not equal to
4.	$=$	is equal to
5.	\geq	is greater than or equal to
6.	\leq	is less than or equal to

7. The opposite of nonzero number a is $\underline{-a}$.
8. The reciprocal of nonzero number a is $\underline{\frac{1}{a}}$.
9. The commutative property has to do with "order."
10. The associative property has to do with "grouping."
11. $a(b + c) = ab + ac$ illustrates the distributive property.
12. For every real number a , $-(-a) = \underline{a}$.
13. $=, \neq, <, \leq, >, \geq$
14. A zero after the last digit to the right of the decimal point does not change the value of the number.

15. *Reciprocal* is the same as multiplicative inverse, and *opposite* is the same as additive inverse.

16. order; grouping

Exercise Set 1.3

2. The difference of y and 3 amounts to 12 is written as $y - 3 = 12$.

4. Three more than the product of 4 and c is 7 is written as $4c + 3 = 7$.

6. The quotient of 8 and y is 3 more than y is written as $\frac{8}{y} = y + 3$.

8. Five added to one-fourth q is the same as 4 more than q is written as $5 + \frac{1}{4}q = q + 4$.

10. -5 is to the left of 0, so $-5 < 0$.

12. -14 is to the right of -24 , so $-14 > -24$.

14. $\frac{20}{5} = 4$, $\frac{20}{4} = 5$, and 4 is to the left of 5, so $\frac{20}{5} < \frac{20}{4}$.

16. $\frac{12}{4} = 3$, $\frac{15}{5} = 3$, and $3 = 3$; so $\frac{12}{4} = \frac{15}{5}$.

18. -4.7 is to the left of 3.8, so $-4.7 < 3.8$.

20. The denominators are the same, so $\frac{9}{20} > \frac{3}{20}$ since $9 > 3$.

22. By dividing, we see that $\frac{3}{4} = 0.75$ and $\frac{7}{8} = 0.875$. Thus, $\frac{3}{4} < \frac{7}{8}$, since $0.75 < 0.875$.

24. -13.07 is to the right of -13.7 , so $-13.07 > -13.7$.

26. False, since neither $0 < -4$ nor $0 = -4$ is true.

28. True, since $-8 = -8$ is true.

30. True, since $-14 < -1$ is true.

32. True, since $-8 = -8$ is true.

34. The opposite of 15 is -15 .

36. The opposite of -7.8 is $-(-7.8)$ or 7.8.

38. The opposite of $\frac{9}{5}$ is $-\frac{9}{5}$.

40. The opposite of $-\frac{14}{3}$ is $-\left(-\frac{14}{3}\right)$ or $\frac{14}{3}$.

42. The opposite of 10.3 is -10.3 .

44. The reciprocal of 9 is $\frac{1}{9}$.

46. The reciprocal of -4 is $-\frac{1}{4}$.

48. The reciprocal of $\frac{1}{9}$ is 9.

50. The reciprocal of $\frac{0}{6}$ is undefined, since there is no number that when multiplied by $\frac{0}{6}$ gives a product of 1.

52. The reciprocal of $-\frac{23}{5}$ is $-\frac{5}{23}$ since $\left(-\frac{23}{5}\right)\left(-\frac{5}{23}\right) = 1$.

	Number	Opposite	Reciprocal
54.	7	-7	$\frac{1}{7}$
56.	-6	6	$-\frac{1}{6}$
58.	$\frac{1}{11}$	$-\frac{1}{11}$	11
60.	1	-1	1
62.	$-\frac{36}{13}$	$\frac{36}{13}$	$-\frac{13}{36}$

64. $3a + 2b = 2b + 3a$ by the commutative property of addition.

66. $r \cdot s = s \cdot r$ by the commutative property of multiplication.
68. $\frac{x}{2} \cdot \frac{9}{10} = \frac{9}{10} \cdot \frac{x}{2}$ by the commutative property of multiplication.
70. $3 \cdot (10z) = (3 \cdot 10)z$ or $30z$ by the associative property of multiplication.
72. $5q + (2r + s) = (5q + 2r) + s$ by the associative property of addition.
74. $(9.2x) \cdot y = 9.2(x \cdot y)$ or $9.2xy$ by the associative property of multiplication.
76. $7(y + 2) = 7 \cdot y + 7 \cdot 2 = 7y + 14$
78. $2(7 - y) = 2 \cdot 7 - 2 \cdot y = 14 - 2y$
80. $9(c + 7d) = 9 \cdot c + 9 \cdot 7d = 9c + 63d$
82. $11y(z - 2) = 11y \cdot z - 11y \cdot 2 = 11yz - 22y$
84. $0.5(3a - 4b) = 0.5 \cdot 3a - 0.5 \cdot 4b = 1.5a - 2b$
86. $\frac{1}{3}(4x + 9y) = \frac{1}{3} \cdot 4x + \frac{1}{3} \cdot 9y = \frac{4}{3}x + 3y$
88. $5(3a + b + 9c) = 5 \cdot 3a + 5 \cdot b + 5 \cdot 9c$
 $= 15a + 5b + 45c$
90. $8 + 0 = 8$ by the additive identity property.
92. $4(x + 3) = 4 \cdot x + 4 \cdot 3 = 4x + 12$ by the distributive property.
94. $0 + 5.4 = 5.4$ by the additive identity property.
96. $9y + (x + 3z) = (9y + x) + 3z$ by the associative property of addition.
98. $4 + 8y = 8y + 4$
100. $5(3a)(7b) = 5(21ab) = 105ab$
102. zero; answers may vary
104. no; answers may vary
106. answers may vary
108. $a(b + c) = ab + ac$

Section 1.4 Practice Exercises

1. $|7| = 7$
2. $|-20| = -(-20) = 20$
3. $\left| -\frac{4}{9} \right| = -\left(-\frac{4}{9} \right) = \frac{4}{9}$
4. $-|5.9| = -5.9$
5. $-|-3| = -3$
6. $-7 + (-10) = -(7 + 10) = -17$
7. $8 + (-12) = -4$
8. $-14 + 20 = 6$
9. $-4.6 + (-1.9) = -6.5$
10. $-\frac{2}{3} + \frac{1}{6} = -\frac{2}{3} \cdot \frac{2}{2} + \frac{1}{6} = -\frac{4}{6} + \frac{1}{6} = -\frac{3}{6} = -\frac{1}{2}$
11. $-\frac{1}{7} + \frac{1}{2} = -\frac{1}{7} \cdot \frac{2}{2} + \frac{1}{2} \cdot \frac{7}{7} = -\frac{2}{14} + \frac{7}{14} = \frac{5}{14}$
12. $7 - 14 = 7 + (-14) = -7$
13. $-10 - (-2) = -10 + 2 = -8$
14. $13.3 - (-8.9) = 13.3 + 8.9 = 22.2$
15. $-\frac{1}{3} - \frac{1}{2} = -\frac{1}{3} + \left(-\frac{1}{2} \right)$
 $= -\frac{1}{3} \cdot \frac{2}{2} + \left(-\frac{1}{2} \cdot \frac{3}{3} \right)$
 $= -\frac{2}{6} + \left(-\frac{3}{6} \right)$
 $= -\frac{5}{6}$
16. $18 + 3 - 4 = 21 - 4 = 17$
17. $-3 - 11 + 7 = -3 + (-11) + 7 = -14 + 7 = -7$
18. $-4(-2) = 8$
19. $5\left(-\frac{1}{10} \right) = \frac{5}{1} \cdot \left(-\frac{1}{10} \right) = -\frac{5}{10} = -\frac{1}{2}$
20. $-3.2(0.1) = -0.32$

21. $8(-6) = -48$

22. $-\frac{2}{5}\left(-\frac{1}{3}\right) = \frac{2}{15}$

23. $(-1.3)(-1.5) = 1.95$

24. $0(-10) = 0$

25. $\frac{45}{-9} = -5$

26. $\frac{-16}{-4} = 4$

27. $\frac{25}{-5} = -5$

28. $\frac{-3}{0}$ is undefined.

29. $\frac{0}{-3} = 0$

30. $\frac{-10}{-40} = \frac{1}{4}$

31. $-\frac{3}{4} \div \left(-\frac{3}{8}\right) = -\frac{3}{4} \cdot \left(-\frac{8}{3}\right) = \frac{24}{12} = 2$

32. $-\frac{1}{11} \div \frac{2}{7} = -\frac{1}{11} \cdot \left(\frac{7}{2}\right) = -\frac{7}{22}$

33. $4^2 = 4 \cdot 4 = 16$

34. $-3^2 = -(3 \cdot 3) = -9$

35. $-3^3 = -(3 \cdot 3 \cdot 3) = -27$

36. $\left(\frac{1}{3}\right)^4 = \left(\frac{1}{3}\right)\left(\frac{1}{3}\right)\left(\frac{1}{3}\right)\left(\frac{1}{3}\right) = \frac{1}{81}$

37. $(-3)^2 = (-3)(-3) = 9$

38. $(-3)^3 = (-3)(-3)(-3) = -27$

39. $\sqrt{36} = 6$, since 6 is positive and $6^2 = 36$.

40. $\sqrt{4} = 2$, since 2 is positive and $2^2 = 4$.

41. $\sqrt{\frac{1}{49}} = \frac{1}{7}$, since $\frac{1}{7}$ is positive and $\left(\frac{1}{7}\right)^2 = \frac{1}{49}$.

42. $\sqrt[3]{64} = 4$, since $4^3 = 64$.

43. $\sqrt[4]{1} = 1$, since 1 is positive and $1^4 = 1$.

44. $\sqrt[5]{243} = 3$, since $3^5 = 243$.

Vocabulary, Readiness & Video Check 1.4

1. b, c

2. a, b

3. b, d

4. a, d

5. b

6. a

7. $0 \cdot a = \underline{0}$ 8. $\frac{0}{4}$ simplifies to $\underline{0}$ while $\frac{4}{0}$ is undefined.9. The reciprocal of the nonzero number b is $\frac{1}{b}$.10. The fraction $-\frac{a}{b} = \frac{-a}{\underline{b}} = \frac{a}{\underline{-b}}$.11. An exponent is a shorthand notation for repeated multiplication of the same number.12. In $(-5)^2$, the 2 is the exponent and the -5 is the base.13. The opposite of squaring a number is taking the square root of a number.14. The absolute value of a number is that number's distance from 0 on a number line.15. The absolute value of a number is that number's distance from zero on a number line. Or, more formally, $|a| = a$ if a is $\underline{0}$ or a positive number. Also, $|a| = -a$ if a is a negative number.

16. addition

17. 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.

18. 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.

19. the positive or principal square root

Exercise Set 1.4

2. $|8| = 8$

4. $|-6| = 6$

6. $|-1| = 1$

8. $-|11| = -11$

10. $-\left|-\frac{5}{13}\right| = -\frac{5}{13}$

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

14. $-5 + (-9) = -14$

16. $-8.2 - (-6.6) = -8.2 + 6.6 = -1.6$

18. $13 - 17 = 13 + (-17) = -4$

20.
$$\begin{aligned}\frac{7}{10} - \left(-\frac{4}{5}\right) &= \frac{7}{10} + \frac{4}{5} \\ &= \frac{7}{10} + \frac{4}{5} \cdot \frac{2}{2} \\ &= \frac{7}{10} + \frac{8}{10} \\ &= \frac{15}{10} \\ &= \frac{3}{2}\end{aligned}$$

22. $-13 - 4 + 9 = -13 + (-4) + 9 = -17 + 9 = -8$

24. $-6 - 31 = -6 + (-31) = -37$

26.
$$\begin{aligned}-\frac{5}{2} - \left(-\frac{2}{3}\right) &= -\frac{5}{2} + \frac{2}{3} \\ &= -\frac{5}{2} \cdot \frac{3}{3} + \frac{2}{3} \cdot \frac{2}{2} \\ &= -\frac{15}{6} + \frac{4}{6} \\ &= -\frac{11}{6}\end{aligned}$$

28. $-3 - 9 = -3 + (-9) = -12$

30. $-3 \cdot 8 = -24$

32. $-4(-11) = 44$

34. $-5 \cdot 0 = 0$

36. $0(-34) = 0$

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

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

42. $5\left(-\frac{1}{50}\right) = -\frac{1}{10}$

44. $(-0.9)(-0.5) = 0.45$

46. $22.5 \div (-2.5) = -9$

48. $-5(-3)(-2) = 15(-2) = -30$

50. $(-7)^2 = (-7)(-7) = 49$

52. $-6^2 = -(6 \cdot 6) = -36$

54. $-2^3 = -(2 \cdot 2 \cdot 2) = -8$

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

58. $\sqrt{81} = 9$, since $9^2 = 81$.

60. $\sqrt{100} = 10$, since $10^2 = 100$.

62. $\sqrt{\frac{1}{25}} = \frac{1}{5}$, since $\left(\frac{1}{5}\right)^2 = \frac{1}{25}$.

64. $\sqrt[4]{81} = 3$, since $3^4 = 81$.
66. $\sqrt{\frac{4}{81}} = \frac{2}{9}$, since $\left(\frac{2}{9}\right)^2 = \frac{4}{81}$.
68. $-9 + 15 = 6$
70. $-17 + (-2) = -19$
72. $5(-4) = -20$
74. $-6 \cdot 7 = -42$
76. $-11^2 = -(11 \cdot 11) = -121$
78. $\frac{35}{-7} = -5$
80. $-42 \div 6 = -7$
82. $\frac{5}{9} \cdot \left(-\frac{3}{5}\right) = -\frac{15}{45} = -\frac{1}{3}$
84. $-5(-4.2) = 21$
86. $-5 - (-17) = -5 + 17 = 12$
88. $15.9 - 21.7 = 15.9 + (-21.7) = -5.8$
90. $\frac{0}{-11} = 0$
92. $\frac{-22}{0}$ is undefined.
94. $\sqrt{\frac{1}{49}} = \frac{1}{7}$
96. $\frac{-9}{13} \div (-3) = \frac{-9}{13} \cdot \left(-\frac{1}{3}\right) = \frac{9}{39} = \frac{3}{13}$
98. $\frac{-4.2}{-1.4} = 3$
100. $-88 \div (-11) = 8$
102. $\sqrt[3]{1} = 1$, since $1^3 = 1$.
104. $\sqrt[3]{125} = 5$, since $5^3 = 125$.
106. $\frac{4}{7} \div \left(-\frac{1}{8}\right) = \frac{4}{7} \cdot \left(-\frac{8}{1}\right) = -\frac{32}{7}$
108. $\frac{5}{6} \cdot \left(-\frac{12}{15}\right) = -\frac{60}{90} = -\frac{2}{3}$
110. $\frac{2}{7} \div \left(-\frac{1}{14}\right) = \frac{2}{7} \cdot \left(-\frac{14}{1}\right) = -\frac{28}{7} = -4$
112. $-14 - 3 + 6 = -14 + (-3) + 6 = -17 + 6 = -11$
114. $-8 + (-10) - 6 = -18 - 6 = -18 + (-6) = -24$
116. $-6(2)(-3) = -12(-3) = 36$
118. $4(-3)(0) = -12(0) = 0$
120. $(-4)^4 = (-4)(-4)(-4)(-4) = 256$
122. answers may vary
124. True; $\frac{-100}{-5} = 20$ and $-100 + (-5) = -105$ and $20 > -105$, since 20 is to the right of -105 .
126. $1 - \frac{8}{35} - \frac{4}{35} - \frac{9}{35} = \frac{35}{35} - \frac{8}{35} - \frac{4}{35} - \frac{9}{35}$
 $= \frac{27}{35} - \frac{4}{35} - \frac{9}{35}$
 $= \frac{23}{35} - \frac{9}{35}$
 $= \frac{14}{35}$
 $= \frac{2}{5}$
128. $29,028 - (-1312) = 29,028 + 1312 = 30,340$
 There is a 30,340 foot difference in elevation.
130. Since spinners a, c, and d have unequal sectors of each color, spinners a, c, and d would lead to an unfair game.
132. For player 1 to lose, he would want to choose spinner d since spinner d has the smallest yellow area.
134. Yes, a two-way tie could occur if two players have 6 points each (the third player has 0 points); or two players have 5 points each (the third player has 2 points).

136. $\sqrt{10} \approx 3.1623$

138. $\sqrt{7.9} \approx 2.8107$

140. After 5 years, a person investing in common stocks may expect to lose at most an average of 17% per year.

142. After 5 years, the highest average annual return is 23% and the lowest average annual return is -17%.

$$23 - (-17) = 23 + 17 = 40$$

The difference is 40%.

Integrated Review

1. $\{x|x \text{ is a natural number less than } 4\} = \{1, 2, 3\}$

2. $\{x|x \text{ is an odd whole number less than } 6\}$
 $= \{1, 3, 5\}$

3. $\{x|x \text{ is an even natural number greater than } 7\}$
 $= \{8, 10, 12, \dots\}$

4. $\{x|x \text{ is a whole number between } 10 \text{ and } 15\}$
 $= \{11, 12, 13, 14\}$

5. Twice the difference of a number and three is written as $2(x - 3)$.

6. The quotient of six and the sum of a number and ten is written as $\frac{6}{x+10}$.

7. -4 is to the right of -6 so $-4 > -6$.

8. The true statement is $8.6 = 8.600$.

9. The denominators are the same so $\frac{9}{10} < \frac{11}{10}$ since $9 < 11$.

10. -6.1 is to the left of -6.01 so $-6.1 < -6.01$.

11. The product of 5 and x is the same as 20 is written as $5x = 20$.

12. The sum of a and 12 amounts to 14 is written as $a + 12 = 14$.

13. The quotient of y and 10 is the same as the product of y and 10 is written as $\frac{y}{10} = y \cdot 10$.

14. The sum of x and negative 1 equals the difference of x and 1 is written as $x + (-1) = x - 1$.

15. $-4 + 7 = 3$

16. $-11 + 20 = 9$

17. $-4(7) = -28$

18. $-11(20) = -220$

19. $-8 - (-13) = -8 + 13 = 5$

20. $-12 - 16 = -12 + (-16) = -28$

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

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

23. $-5^2 = -(5 \cdot 5) = -25$

24. $(-5)^2 = (-5)(-5) = 25$

25. $-6 - 1 + 20 = -6 + (-1) + 20 = -7 + 20 = 13$

$$\begin{aligned} 26. \quad 18 - 4 - 19 &= 18 + (-4) - 19 \\ &= 14 - 19 \\ &= 14 + (-19) \\ &= -5 \end{aligned}$$

27. $\frac{0}{-3} = 0$

28. $\frac{5}{0}$ is undefined.

29. $-4(3)(2) = -12(2) = -24$

30. $-5(-1)(6) = 5(6) = 30$

31. $-\frac{1}{2} \cdot \frac{6}{7} = -\frac{6}{14} = -\frac{3}{7}$

32. $\frac{4}{5} \cdot \left(-\frac{1}{8}\right) = -\frac{4}{40} = -\frac{1}{10}$

$$\begin{aligned}
 33. \quad \frac{3}{10} - \frac{4}{5} &= \frac{3}{10} + \left(-\frac{4}{5}\right) \\
 &= \frac{3}{10} + \left(-\frac{4 \cdot 2}{5 \cdot 2}\right) \\
 &= \frac{3}{10} + \left(-\frac{8}{10}\right) \\
 &= -\frac{5}{10} \\
 &= -\frac{1}{2}
 \end{aligned}$$

$$\begin{aligned}
 34. \quad -\frac{2}{3} - \frac{1}{4} &= -\frac{2}{3} + \left(-\frac{1}{4}\right) \\
 &= -\frac{2}{3} \cdot \frac{4}{4} + \left(-\frac{1 \cdot 3}{4 \cdot 3}\right) \\
 &= -\frac{8}{12} + \left(-\frac{3}{12}\right) \\
 &= -\frac{11}{12}
 \end{aligned}$$

$$35. \quad \frac{1.6}{-0.2} = -8$$

$$36. \quad -\frac{4.8}{16} = -0.3$$

$$37. \quad 6.7 - (-1.3) = 6.7 + 1.3 = 8$$

$$38. \quad -4.6 + 9 = 4.4$$

$$39. \quad \frac{1}{2} + \left(-\frac{7}{8}\right) = \frac{1}{2} \cdot \frac{4}{4} + \left(-\frac{7}{8}\right) = \frac{4}{8} + \left(-\frac{7}{8}\right) = -\frac{3}{8}$$

$$40. \quad \frac{1}{2} \div \left(-\frac{7}{8}\right) = \frac{1}{2} \cdot \left(-\frac{8}{7}\right) = -\frac{8}{14} = -\frac{4}{7}$$

$$41. \quad \sqrt{49} = 7, \text{ since } 7^2 = 49.$$

$$42. \quad \sqrt[3]{27} = 3, \text{ since } 3^3 = 27.$$

$$43. \quad -2^2 = -(2 \cdot 2) = -4$$

$$44. \quad (-2)^3 = (-2)(-2)(-2) = -8$$

$$45. \quad \sqrt{\frac{1}{81}} = \frac{1}{9}, \text{ since } \left(\frac{1}{9}\right)^2 = \frac{1}{81}.$$

$$46. \quad \sqrt{\frac{1}{100}} = \frac{1}{10}, \text{ since } \left(\frac{1}{10}\right)^2 = \frac{1}{100}.$$

	Number	Opposite	Reciprocal
47.	-6	6	$-\frac{1}{6}$
48.	4	-4	$\frac{1}{4}$
49.	$\frac{5}{7}$	$-\frac{5}{7}$	$\frac{7}{5}$
50.	$-\frac{7}{30}$	$\frac{7}{30}$	$-\frac{30}{7}$

$$51. \quad 9(m + 5) = 9 \cdot m + 9 \cdot 5 = 9m + 45$$

$$52. \quad 11(7 + r) = 11 \cdot 7 + 11 \cdot r = 77 + 11r$$

$$53. \quad 3(2y - 3x) = 3 \cdot 2y - 3 \cdot 3x = 6y - 9x$$

$$54. \quad 8(4m - 7n) = 8 \cdot 4m - 8 \cdot 7n = 32m - 56n$$

$$55. \quad 0.2(3a + 7) = 0.2 \cdot 3a + 0.2 \cdot 7 = 0.6a + 1.4$$

$$56. \quad 0.6(2n + 5) = 0.6 \cdot 2n + 0.6 \cdot 5 = 1.2n + 3$$

$$\begin{aligned}
 57. \quad \frac{1}{5}(10x - 19y + 20) &= \frac{1}{5} \cdot 10x - \frac{1}{5} \cdot 19y + \frac{1}{5} \cdot 20 \\
 &= 2x - \frac{19}{5}y + 4
 \end{aligned}$$

$$\begin{aligned}
 58. \quad \frac{1}{2}(10x - 19y + 20) &= \frac{1}{2} \cdot 10x - \frac{1}{2} \cdot 19y + \frac{1}{2} \cdot 20 \\
 &= 5x - \frac{19}{2}y + 10
 \end{aligned}$$

Section 1.5 Practice Exercises

$$1. \quad 15 - 2 \cdot 5 = 15 - 10 = 5$$

$$\begin{aligned}
 2. \quad 2 + 5(2 - 6)^2 &= 2 + 5(-4)^2 \\
 &= 2 + 5(16) \\
 &= 2 + 80 \\
 &= 82
 \end{aligned}$$

$$3. \quad \frac{|-3|^2 + 5}{\sqrt{9} - 10} = \frac{3^2 + 5}{3 - 10} = \frac{9 + 5}{-7} = \frac{14}{-7} = -2$$

$$\begin{aligned}
 4. \quad 7 - [2(1-3) + 5(10-12)] &= 7 - [2(-2) + 5(-2)] \\
 &= 7 - [-4 + (-10)] \\
 &= 7 - [-14] \\
 &= 7 + 14 \\
 &= 21
 \end{aligned}$$

$$\begin{aligned}
 5. \quad \frac{|9-16|+5^2}{-3\sqrt{8+1}+(-4)^2} &= \frac{|-7|+5^2}{-3\sqrt{9}+(-4)^2} \\
 &= \frac{7+25}{-3 \cdot 3+16} \\
 &= \frac{32}{-9+16} \\
 &= \frac{32}{7}
 \end{aligned}$$

$$\begin{aligned}
 6. \quad \text{a.} \quad &\text{Replace } x \text{ with } 9 \text{ and } y \text{ with } -4. \\
 &2x - 6y = 2 \cdot 9 - 6(-4) \\
 &= 18 - (-24) \\
 &= 18 + 24 \\
 &= 42
 \end{aligned}$$

$$\begin{aligned}
 \text{b.} \quad &\text{Replace } y \text{ with } -4. \\
 &-3y^2 = -3(-4)^2 = -3(16) = -48
 \end{aligned}$$

$$\begin{aligned}
 \text{c.} \quad &\text{Replace } x \text{ with } 9 \text{ and } y \text{ with } -4. \\
 &\frac{\sqrt{x}}{y} + \frac{y}{x} = \frac{\sqrt{9}}{-4} + \left(-\frac{4}{9}\right) \\
 &= -\frac{3}{4} \cdot \frac{9}{9} + \left(-\frac{4}{9} \cdot \frac{4}{4}\right) \\
 &= -\frac{27}{36} + \left(-\frac{16}{36}\right) \\
 &= -\frac{43}{36}
 \end{aligned}$$

7. To complete the table, we evaluate $\frac{5(x-32)}{9}$ at each given replacement value.

$$\text{a.} \quad \text{When } x = -13, \quad \frac{5(-13-32)}{9} = \frac{5(-45)}{9} = -25.$$

$$\text{b.} \quad \text{When } x = 0, \quad \frac{5(0-32)}{9} = \frac{5(-32)}{9} = \frac{-160}{9} = -17\frac{7}{9}.$$

$$\text{c.} \quad \text{When } x = 41, \quad \frac{5(41-32)}{9} = \frac{5(9)}{9} = 5.$$

$$8. \quad 9x - 15x + 7 = (9 - 15)x + 7 = -6x + 7$$

$$9. \quad 8y + y = 8y + 1y = (8 + 1)y = 9y$$

$$\begin{aligned}
 10. \quad 4x + 12x - 9 - 10 &= (4 + 12)x + (-9 - 10) \\
 &= 16x - 19
 \end{aligned}$$

$$\begin{aligned}
 11. \quad -4x + 7 - 5x - 8 &= -4x - 5x + 7 - 8 \\
 &= (-4 - 5)x + (7 - 8) \\
 &= -9x - 1
 \end{aligned}$$

$$\begin{aligned}
 12. \quad 5y - 6y + 2 - 11 + 2y &= 5y - 6y + 2y + 2 - 11 \\
 &= (5 - 6 + 2)y + (2 - 11) \\
 &= 1y - 9 \\
 &= y - 9
 \end{aligned}$$

$$\begin{aligned}
 13. \quad -3(y+1) + 4 &= -3(y) + (-3)(1) + 4 \\
 &= -3y - 3 + 4 \\
 &= -3y + 1
 \end{aligned}$$

$$14. \quad 8x + 2 - 4(x - 9) = 8x + 2 - 4x + 36 = 4x + 38$$

$$\begin{aligned}
 15. \quad (3.2x - 4.1) - (-x + 7.6) \\
 &= (3.2x - 4.1) - 1(-x + 7.6) \\
 &= 3.2x - 4.1 + 1x - 7.6 \\
 &= 4.2x - 11.7
 \end{aligned}$$

$$\begin{aligned}
 16. \quad \frac{1}{5}(15m - 40n) - \frac{1}{4}(8m - 4n + 1) + \frac{1}{5} \\
 &= 3m - 8n - 2m + 1n - \frac{1}{4} + \frac{1}{5} \\
 &= m - 7n - \frac{1}{20}
 \end{aligned}$$

Vocabulary, Readiness & Video Check 1.5

- Terms with the same variable(s) raised to the same powers are called like terms.
- The terms of an expression are the addends of the expression.
- The process of adding or subtracting like terms is called combining like terms.
- Using order of operations, $9 \div 3 \cdot 3 = \underline{9}$.
- It allows each expression to evaluate to a single number.
- The 2 is part of a multiplication that must happen before addition in the order of operations.
- by combining like terms; distributive property

Exercise Set 1.5

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

$$4. \quad -5^2 - 2^4 = -25 - 16 = -41$$

$$6. \quad \frac{4.2 - (-8.2)}{-0.4} = \frac{12.4}{-0.4} = -31$$

$$8. \quad |8.6 - 1.9| - |2.1 + 5.3| = |6.7| - |7.4| \\ = 6.7 - 7.4 \\ = -0.7$$

$$10. \quad (-15)^2 - 2^4 = 225 - 16 = 209$$

$$12. \quad -20 \div 5 \cdot 4 = -4 \cdot 4 = -16$$

$$14. \quad 3[11 - (1 - 3)] = 3[11 - (-2)] = 3[13] = 39$$

$$16. \quad -10\left(-\frac{2}{5}\right) - 10 = 4 - 10 = -6$$

$$18. \quad 8 - [(4 - 7) + (8 - 1)] = 8 - [-3 + 7] \\ = 8 - [4] \\ = 4$$

$$20. \quad \frac{(-1-2)(-3^2)}{-6-3} = \frac{(-3)(-9)}{-9} = -3$$

$$22. \quad (\sqrt[3]{27})(-5) - (\sqrt{25})(-3) = (3)(-5) - (5)(-3) \\ = -15 - (-15) \\ = 0$$

$$24. \quad 18 + \{9 - [1 - 6(-3)]\} = 18 + \{9 - [1 - (-18)]\} \\ = 18 + \{9 - [19]\} \\ = 18 + \{-10\} \\ = 8$$

$$26. \quad 10 - [(4-5)^2 + (12-14)]^4 \\ = 10 - [(-1)^2 + (-2)]^4 \\ = 10 - [1 + (-2)]^4 \\ = 10 - [-1]^4 \\ = 10 - 1 \\ = 9$$

$$28. \quad \frac{-\sqrt{16} - (6 - 2.4)}{-2} = \frac{-4 - (6 - 2.4)}{-2} \\ = \frac{-4 - (3.6)}{-2} \\ = \frac{-7.6}{-2} \\ = 3.8$$

$$30. \quad \frac{|-14| - |2 - 7|}{-15} = \frac{|-14| - |-5|}{-15} = \frac{14 - 5}{-15} = \frac{9}{-15} = -\frac{3}{5}$$

$$32. \quad \frac{-1-2}{2(-3)+10} - \frac{2(-5)}{-1(8)+1} = \frac{-3}{-6+10} - \frac{-10}{-8+1} \\ = -\frac{3}{4} - \frac{-10}{-7} \\ = -\frac{3}{4} - \frac{10}{7} \\ = -\frac{3}{4} \cdot \frac{7}{7} - \frac{10}{7} \cdot \frac{4}{4} \\ = -\frac{21}{28} - \frac{40}{28} \\ = -\frac{61}{28}$$

$$34. \quad \frac{\frac{1}{5} \cdot 20 - 6}{10 + \frac{1}{4} \cdot 12} = \frac{4 - 6}{10 + 3} = \frac{-2}{13} = -\frac{2}{13}$$

$$36. \quad 2\{-1 + 3[7 - 4(-10 + 12)]\} = 2\{-1 + 3[7 - 4(2)]\} \\ = 2\{-1 + 3[7 - 8]\} \\ = 2\{-1 + 3[-1]\} \\ = 2\{-1 + [-3]\} \\ = 2\{-4\} \\ = -8$$

$$38. \quad \frac{(-2)^4 + 3\sqrt{120 - 20}}{4^3 + |5(-1)|} = \frac{16 + 3\sqrt{100}}{64 + |-5|} \\ = \frac{16 + 3(10)}{64 + 5} \\ = \frac{16 + 30}{69} \\ = \frac{46}{69} \\ = \frac{2}{3}$$

$$40. \quad -290(9.61 - 6.27) = -290(3.34) = -968.6$$

$$42. \quad \left(\frac{9.4 - 10.8}{8.7 - 7.9}\right)^2 = \left(\frac{-1.4}{0.8}\right)^2 = (-1.75)^2 = 3.0625$$

44. Replace x with 9 and y with -2 .

$$\begin{aligned}4x - 10y &= 4(9) - 10(-2) \\&= 36 - (-20) \\&= 36 + 20 \\&= 56\end{aligned}$$

46. Replace y with -2 .

$$-7y^2 = -7(-2)^2 = -7(4) = -28$$

48. Replace x with 9 and y with -2 .

$$\begin{aligned}\frac{y}{2x} - \frac{\sqrt{x}}{3y} &= \frac{-2}{2(9)} - \frac{\sqrt{9}}{3(-2)} \\&= -\frac{2}{18} - \frac{3}{-6} \\&= -\frac{2}{18} + \frac{3}{6} \\&= -\frac{2}{18} + \frac{3 \cdot 3}{6 \cdot 3} \\&= -\frac{2}{18} + \frac{9}{18} \\&= \frac{7}{18}\end{aligned}$$

50. Replace x with 9 and y with -2 .

$$\begin{aligned}\frac{5 + 2|y - x|}{x + 6y} &= \frac{5 + 2|-2 - 9|}{9 + 6(-2)} \\&= \frac{5 + 2|-11|}{9 + (-12)} \\&= \frac{5 + 2(11)}{-3} \\&= \frac{5 + 22}{-3} \\&= -\frac{27}{3} \\&= -9\end{aligned}$$

52. Replace x with 9 and y with -2 .

$$\begin{aligned}\frac{y^2 + \sqrt{x+7}}{|3x - y|} &= \frac{(-2)^2 + \sqrt{9+7}}{|3(9) - (-2)|} \\&= \frac{4 + \sqrt{16}}{|27 + 2|} \\&= \frac{4 + 4}{|29|} \\&= \frac{8}{29}\end{aligned}$$

54. a.

Radius, r	Area, πr^2
2	$(3.14)(2)^2 = 3.14(4) = 12.56$
3	$(3.14)(3)^2 = 3.14(9) = 28.26$
7	$(3.14)(7)^2 = 3.14(49) = 153.86$
10	$(3.14)(10)^2 = 3.14(100) = 314$

b. As the radius increases, the area increases; answers may vary.

56. a.

Degrees Celsius, C	Degrees Fahrenheit, $1.8C + 32$
-10	$1.8(-10) + 32 = -18 + 32 = 14$
0	$1.8(0) + 32 = 0 + 32 = 32$
50	$1.8(50) + 32 = 90 + 32 = 122$

b. As degrees Celsius increases, degrees Fahrenheit increase; answers may vary.

58. Replace t with 5.

$$377.75t = 377.75(5) = 1888.75$$

In 5 seconds, the comet covered 1888.75 kilometers.

60. $9y - 11y = (9 - 11)y = -2y$

62. $14x - x = 14x - 1x = (14 - 1)x = 13x$

64. $14x - 1 - 20x = 14x - 20x - 1$
 $= (14 - 20)x - 1$
 $= -6x - 1$

66. $5y - 14 + 7y - 20y = 5y + 7y - 20y - 14$
 $= (5 + 7 - 20)y - 14$
 $= -8y - 14$

68. $11x - y + 11x - 6y = 11x + 11x - 1y - 6y$
 $= (11 + 11)x + (-1 - 6)y$
 $= 22x - 7y$

70. $a - b + 3a - 3b = 1a + 3a - 1b - 3b$
 $= (1 + 3)a + (-1 - 3)b$
 $= 4a - 4b$

72. $6.3y - 9.7 + 2.2y - 11.1$
 $= 6.3y + 2.2y - 9.7 - 11.1$
 $= 8.5y - 20.8$

$$\begin{aligned}
 74. \quad \frac{7}{8}a - \frac{11}{12} - \frac{1}{2}a + \frac{5}{6} &= \frac{7}{8}a - \frac{1}{2}a - \frac{11}{12} + \frac{5}{6} \\
 &= \frac{7}{8}a - \frac{4}{8}a - \frac{11}{12} + \frac{10}{12} \\
 &= \frac{3}{8}a - \frac{1}{12}
 \end{aligned}$$

$$\begin{aligned}
 76. \quad 4mn - 6.01 - 6mn - 8.1 &= 4mn - 6mn - 6.01 - 8.1 \\
 &= -2mn - 14.11
 \end{aligned}$$

$$78. \quad 4(5y + 12) = 4 \cdot 5y + 4 \cdot 12 = 20y + 48$$

$$\begin{aligned}
 80. \quad -11c - (4 - 2c) &= -11c - 4 + 2c \\
 &= -11c + 2c - 4 \\
 &= -9c - 4
 \end{aligned}$$

$$\begin{aligned}
 82. \quad (8 - 5y) - (4 - 3y) &= 8 - 5y - 4 + 3y \\
 &= 8 - 4 - 5y + 3y \\
 &= 4 - 2y
 \end{aligned}$$

$$\begin{aligned}
 84. \quad 4(yz + 3) - 7yz + 1 + y^2 \\
 &= 4yz + 12 - 7yz + 1 + y^2 \\
 &= y^2 + 4yz - 7yz + 12 + 1 \\
 &= y^2 - 3yz + 13
 \end{aligned}$$

$$\begin{aligned}
 86. \quad -(8 - t) + (2t - 6) &= -8 + t + 2t - 6 \\
 &= 1t + 2t - 8 - 6 \\
 &= 3t - 14
 \end{aligned}$$

$$\begin{aligned}
 88. \quad 5(2z - 6) + 10(3 - z) &= 10z - 30 + 30 - 10z \\
 &= 10z - 10z - 30 + 30 \\
 &= 0
 \end{aligned}$$

$$\begin{aligned}
 90. \quad \frac{1}{4}(8x - 4) - \frac{1}{5}(20x - 6y) &= 2x - 1 - 4x + \frac{6}{5}y \\
 &= 2x - 4x + \frac{6}{5}y - 1 \\
 &= -2x + \frac{6}{5}y - 1
 \end{aligned}$$

$$\begin{aligned}
 92. \quad 7n + 3(2n - 6) - n &= 7n + 6n - 18 - n \\
 &= 7n + 6n - n - 18 \\
 &= 12n - 18
 \end{aligned}$$

$$\begin{aligned}
 94. \quad \frac{1}{3}(6x - 33y) - \frac{1}{8}(24x - 40y + 1) - \frac{1}{3} \\
 &= 2x - 11y - 3x + 5y - \frac{1}{8} - \frac{1}{3} \\
 &= 2x - 3x - 11y + 5y - \frac{3}{24} - \frac{8}{24} \\
 &= -x - 6y - \frac{11}{24}
 \end{aligned}$$

$$\begin{aligned}
 96. \quad 6.2b + 5.1 - 2(4.2b - 0.1) &= 6.2b + 5.1 - 8.4b + 0.2 \\
 &= 6.2b - 8.4b + 5.1 + 0.2 \\
 &= -2.2b + 5.3
 \end{aligned}$$

$$\begin{aligned}
 98. \quad -5[3(4x + 2) - (13 + 8x)] &= -5[12x + 6 - 13 - 8x] \\
 &= -5[12x - 8x + 6 - 13] \\
 &= -5[4x - 7] \\
 &= -20x + 35
 \end{aligned}$$

$$\begin{aligned}
 100. \quad 5.8(-9.6 - 31.2y) - 18.65 \\
 &= -55.68 - 180.96y - 18.65 \\
 &= -180.96y - 55.68 - 18.65 \\
 &= -180.96y - 74.33
 \end{aligned}$$

$$\begin{aligned}
 102. \quad 6.5y - 4.4(1.8y - 3.3) + 10.95 \\
 &= 6.5y - 7.92y + 14.52 + 10.95 \\
 &= -1.42y + 25.47
 \end{aligned}$$

$$104. \quad 6 - (5 \cdot 2 + 2) = 6 - (10 + 2) = 6 - (12) = -6$$

$$106. \quad \text{answers may vary}$$

$$108. \quad 2 + 3(7 - 6x) = 2 + 21 - 18x = 23 - 18x$$

$$110. \quad \text{From the graph, the predicted population over 65 in 2050 will be 80 million.}$$

$$112. \quad \text{From the graph, the population that was over 65 in 2000 was about 35 million.}$$

$$114. \quad 2.5(8.1) = 20.25\%; \text{ the percent of Americans expected to be over 65 in 2050 is 20.25.}$$

$$\begin{aligned}
 116. \quad 1 - \frac{2}{9} - \frac{1}{6} - \frac{1}{4} &= \frac{36}{36} - \frac{2}{9} - \frac{1}{6} - \frac{1}{4} = \frac{36}{36} - \frac{8}{36} - \frac{6}{36} - \frac{9}{36} \\
 &= \frac{36}{36} - \frac{8}{36} - \frac{6}{36} - \frac{9}{36} \\
 &= \frac{28}{36} - \frac{6}{36} - \frac{9}{36} \\
 &= \frac{22}{36} - \frac{9}{36} \\
 &= \frac{13}{36}
 \end{aligned}$$

118. Let $x_1 = 2$, $x_2 = 4$, $y_1 = -3$, $y_2 = 2$.

$$\begin{aligned} & \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(4 - 2)^2 + [2 - (-3)]^2} \\ &= \sqrt{2^2 + 5^2} \\ &= \sqrt{4 + 25} \\ &= \sqrt{29} \end{aligned}$$

120. $\frac{(-5.161)(3.222)}{7.955 - 19.676} \approx \frac{-16.6287}{-11.721} \approx 1.4187$

Section 1.6 Practice Exercises

1. $5^2 \cdot 5^6 = 5^{2+6} = 5^8$

2. $x^5 \cdot x^9 = x^{5+9} = x^{14}$

3. $y \cdot y^4 \cdot y^3 = (y^1 \cdot y^4) \cdot y^3 = y^5 \cdot y^3 = y^8$

4. $(7y^5)(6y) = 7(6)y^5y^1 = 42y^6$

5. $(-3x^2y^7)(5xy^6) = -3(5)x^2x^1y^7y^6 = -15x^3y^{13}$

6. $8^0 = 1$

7. $-14^0 = -(14)^0 = -1$

8. $(y-3)^0 = 1$

9. $5x^0 = 5(1) = 5$

10. $\frac{6^{10}}{6^2} = 6^{10-2} = 6^8$

11. $\frac{y^6}{y^2} = y^{6-2} = y^4$

12. $\frac{36x^5}{9x} = 4x^{5-1} = 4x^4$

13. $\frac{10a^7b^9}{15a^5b^9} = \frac{2}{3}a^{7-5} \cdot b^{9-9}$
 $= \frac{2}{3}a^2 \cdot b^0$
 $= \frac{2}{3}a^2(1)$
 $= \frac{2}{3}a^2$

14. $7^{-2} = \frac{1}{7^2} = \frac{1}{49}$

15. $5x^{-4} = 5 \cdot \frac{1}{x^4} = \frac{5}{x^4}$

16. $(2x)^{-1} = \frac{1}{(2x)^1} = \frac{1}{2x}$

17. $3^{-1} + 2^{-2} = \frac{1}{3^1} + \frac{1}{2^2} = \frac{1}{3} + \frac{1}{4} = \frac{4}{12} + \frac{3}{12} = \frac{7}{12}$

18. $\frac{1}{y^{-4}} = \frac{1}{\frac{1}{y^4}} = 1 \div \frac{1}{y^4} = 1 \cdot \frac{y^4}{1} = y^4$

19. $\frac{x^3}{x^{10}} = x^{3-10} = x^{-7} = \frac{1}{x^7}$

20. $\frac{4^2}{4^5} = 4^{2-5} = 4^{-3} = \frac{1}{4^3} = \frac{1}{64}$

21. $y^{-10} \cdot y^3 = y^{-10+3} = y^{-7} = \frac{1}{y^7}$

22. $\frac{q^5}{q^{-4}} = q^{5-(-4)} = q^9$

23. $\frac{5^{-4}}{5^{-2}} = 5^{-4-(-2)} = 5^{-2} = \frac{1}{5^2} = \frac{1}{25}$

24. $\frac{10x^{-8}y^5}{20xy^{-5}} = \frac{x^{-8-1} \cdot y^{5-(-5)}}{2} = \frac{x^{-9} \cdot y^{10}}{2} = \frac{y^{10}}{2x^9}$

$$\begin{aligned}
 25. \quad \frac{(4x^{-1})(x^5)}{x^7} &= \frac{4x^{-1+5}}{x^7} \\
 &= \frac{4x^4}{x^7} \\
 &= 4x^{4-7} \\
 &= 4x^{-3} \\
 &= \frac{4}{x^3}
 \end{aligned}$$

$$26. \quad x^{3m} \cdot x^n = x^{3m+n}$$

$$27. \quad \frac{x^{2m-2}}{x^{m-6}} = x^{(2m-2)-(m-6)} = x^{2m-2-m+6} = x^{m+4}$$

$$28. \quad 1,760,000 = 1.76 \times 10^6$$

$$29. \quad 0.00028 = 2.8 \times 10^{-4}$$

$$30. \quad 8.6 \times 10^7 = 86,000,000$$

$$31. \quad 3.022 \times 10^{-4} = 0.0003022$$

Calculator Explorations

$$1. \quad (3 \times 10^{11}) \cdot (2 \times 10^{32}) = 6 \times 10^{43}$$

$$2. \quad (6 \times 10^{14}) \div (3 \times 10^9) = 2 \times 10^5$$

$$3. \quad (5.2 \times 10^{23}) \cdot (7.3 \times 10^4) = 3.796 \times 10^{28}$$

$$4. \quad (4.38 \times 10^{41}) \div (3 \times 10^{17}) = 1.46 \times 10^{24}$$

Vocabulary, Readiness & Video Check 1.6

$$1. \quad x$$

$$2. \quad z$$

$$3. \quad 3$$

$$4. \quad -3$$

$$5. \quad y^7$$

$$6. \quad 2$$

$$7. \quad 5x^{-1}y^{-2} = \frac{5}{x^1y^2} = \frac{5}{xy^2}$$

$$8. \quad 7xy^{-4} = \frac{7x}{y^4}$$

$$9. \quad a^2b^{-1}c^{-5} = \frac{a^2}{bc^5}$$

$$10. \quad a^{-4}b^2c^{-6} = \frac{b^2}{a^4c^6}$$

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

$$12. \quad \frac{x^{-7}}{z^{-3}} = \frac{z^3}{x^7}$$

13. These properties allow us to reorder and regroup factors to put those with the same bases together so that we may apply the product rule.

14. Since there are no parentheses, the negative is not part of the base and is therefore not raised to the zero power. The evaluation is -1 , not 1 .

15. Subtract the exponents on like bases when applying the quotient rule.

16. A negative exponent will not make an expression evaluate to a negative number. A negative exponent moves an expression or factor from numerator to denominator or from denominator to numerator.

17. quotient rule for exponents

18. When you move the decimal point to the left, the sign of the exponent is positive; when you move the decimal point to the right, the sign of the exponent is negative.

Exercise Set 1.6

$$2. \quad 3^3 \cdot 3^5 = 3^{3+5} = 3^8$$

$$4. \quad a^2 \cdot a^9 = a^{2+9} = a^{11}$$

$$6. \quad n \cdot n^{10} \cdot n^{12} = n^1 \cdot n^{10} \cdot n^{12} = n^{1+10+12} = n^{23}$$

$$\begin{aligned}
 8. \quad (-7xy)(7y) &= -7(7)x^1y^1y^1 \\
 &= -49x^1y^{1+1} \\
 &= -49xy^2
 \end{aligned}$$

$$\begin{aligned} 10. \quad (-6a^2b^3)(-3ab^3) &= -6(-3)a^2a^1b^3b^3 \\ &= 18a^{2+1}b^{3+3} \\ &= 18a^3b^6 \end{aligned}$$

$$12. \quad (-9)^0 = 1$$

$$14. \quad (3x-1)^0 = 1$$

$$16. \quad -5x^0 = -5(1) = -5$$

$$18. \quad 8x^0 + 1 = 8(1) + 1 = 8 + 1 = 9$$

$$20. \quad \frac{x^9}{x^4} = x^{9-4} = x^5$$

$$22. \quad -\frac{16x^5}{8x} = -\frac{16}{8}x^{5-1} = -2x^4$$

$$24. \quad \frac{a^{12}b^2}{a^9b} = a^{12-9}b^{2-1} = a^3b^1 = a^3b$$

$$26. \quad \frac{24a^{10}b^{11}}{10ab^3} = \frac{24}{10}a^{10-1}b^{11-3} = \frac{12}{5}a^9b^8$$

$$\begin{aligned} 28. \quad \frac{49a^3bc^{14}}{-7abc^8} &= \frac{49}{-7}a^{3-1}b^{1-1}c^{14-8} \\ &= -7a^2b^0c^6 \\ &= -7a^2(1)c^6 \\ &= -7a^2c^6 \end{aligned}$$

$$30. \quad 2^{-3} = \frac{1}{2^3} = \frac{1}{8}$$

$$32. \quad (-6)^{-2} = \frac{1}{(-6)^2} = \frac{1}{36}$$

$$34. \quad \frac{z}{z^3} = z^{1-3} = z^{-2} = \frac{1}{z^2}$$

$$36. \quad 10b^{-1} = 10 \cdot \frac{1}{b} = \frac{10}{b}$$

$$38. \quad \frac{p^{-13}}{q^{-3}} = p^{-13} \cdot \frac{1}{q^{-3}} = \frac{1}{p^{13}} \cdot q^3 = \frac{q^3}{p^{13}}$$

$$40. \quad \frac{z^{-12}}{z^{10}} = z^{-12-10} = z^{-22} = \frac{1}{z^{22}}$$

$$42. \quad \frac{3s^3}{15s^{-3}} = \frac{3}{15}s^{3-(-3)} = \frac{1}{5}s^6 = \frac{s^6}{5}$$

$$44. \quad \frac{y^{-7}y}{y^8} = \frac{y^{-7+1}}{y^8} = \frac{y^{-6}}{y^8} = y^{-6-8} = y^{-14} = \frac{1}{y^{14}}$$

$$46. \quad \frac{18ab^{-6}}{3a^{-3}b^6} = \frac{18}{3}a^{1-(-3)}b^{-6-6} = 6a^4b^{-12} = \frac{6a^4}{b^{12}}$$

$$\begin{aligned} 48. \quad \frac{(30z^2)(z^5)}{55z^{-4}} &= \frac{30z^{2+5}}{55z^{-4}} \\ &= \frac{30z^7}{55z^{-4}} \\ &= \frac{30}{55}z^{7-(-4)} \\ &= \frac{6}{11}z^{11} \\ &= \frac{6z^{11}}{11} \end{aligned}$$

$$50. \quad -3y \cdot -9y^4 = -3(-9)y^1y^4 = 27y^{1+4} = 27y^5$$

$$52. \quad y^6 \cdot y \cdot y^9 = y^{6+1+9} = y^{16}$$

$$54. \quad -3z^4 \cdot 10z^7 = -3(10)z^4z^7 = -30z^{4+7} = -30z^{11}$$

$$56. \quad 4y^0 - (4y)^0 = 4(1) - 1 = 4 - 1 = 3$$

$$58. \quad \frac{x^{11}}{x^{20}} = x^{11-20} = x^{-9} = \frac{1}{x^9}$$

$$60. \quad 4^0 + 4x^0 = 1 + 4(1) = 1 + 4 = 5$$

$$62. \quad \frac{y^{-6}}{y^{-9}} = y^{-6-(-9)} = y^3$$

$$64. \quad 1^{-3} - 4^{-2} = \frac{1}{1^3} - \frac{1}{4^2} = \frac{1}{1} - \frac{1}{16} = \frac{16}{16} - \frac{1}{16} = \frac{15}{16}$$

$$66. \quad (4x)^{-1} = \frac{1}{4x}$$

$$68. \frac{x^{-5}}{x^3} = x^{-5-3} = x^{-8} = \frac{1}{x^8}$$

$$\begin{aligned} 70. \frac{a^{-5}b^7}{a^{-2}b^{-3}} &= a^{-5-(-2)}b^{7-(-3)} \\ &= a^{-3}b^{10} \\ &= \frac{1}{a^3} \cdot b^{10} \\ &= \frac{b^{10}}{a^3} \end{aligned}$$

$$\begin{aligned} 72. (-6a^4b)(2b^3)(-3ab^6) &= -6(2)(-3)a^4a^1b^1b^3b^6 \\ &= 36a^{4+1}b^{1+3+6} \\ &= 36a^5b^{10} \end{aligned}$$

$$74. 5^{-2}y = \frac{1}{5^2} \cdot y = \frac{1}{25}y = \frac{y}{25}$$

$$76. \frac{10^{25}}{10^{23}} = 10^{25-23} = 10^2 = 100$$

$$78. \frac{13^{-10}}{13^{-9}} = 13^{-10-(-9)} = 13^{-1} = \frac{1}{13}$$

$$\begin{aligned} 80. \frac{11^{-9}b^3}{11^{-7}b^{-4}} &= 11^{-9-(-7)}b^{3-(-4)} \\ &= 11^{-2}b^7 \\ &= \frac{1}{11^2} \cdot b^7 \\ &= \frac{b^7}{121} \end{aligned}$$

$$\begin{aligned} 82. \frac{30x^{-7}yz^{-14}}{3xyz} &= \frac{30}{3}x^{-7-1}y^{1-1}z^{-14-1} \\ &= 10x^{-8}y^0z^{-15} \\ &= \frac{10}{x^8z^{15}} \end{aligned}$$

$$84. y^{2p} \cdot y^{9p} = y^{2p+9p} = y^{11p}$$

$$86. \frac{y^{4p-2}}{y^{3p}} = y^{4p-2-3p} = y^{p-2}$$

$$88. x^{9y} \cdot x^{-7y} = x^{9y+(-7y)} = x^{2y}$$

$$90. \frac{y^6}{y^{4z}} = y^{6-4z}$$

$$\begin{aligned} 92. \frac{z^{5x} \cdot z^{x-7}}{z^x} &= \frac{z^{5x+x-7}}{z^x} \\ &= \frac{z^{6x-7}}{z^x} \\ &= z^{6x-7-1x} \\ &= z^{5x-7} \end{aligned}$$

$$94. 678,000 = 6.78 \times 10^5$$

$$96. 0.007613 = 7.613 \times 10^{-3}$$

$$98. 36,800,000 = 3.68 \times 10^7$$

$$100. 0.00084 = 8.4 \times 10^{-4}$$

$$102. 98,700,000,000 = 9.87 \times 10^{10}$$

$$104. 140,660,000 = 1.4066 \times 10^8$$

$$106. 101,570,000 = 1.0157 \times 10^8$$

$$108. 27,000,000 = 2.7 \times 10^7$$

$$110. 0.0000164 = 1.64 \times 10^{-5}$$

$$112. 2.7 \times 10^{-5} = 0.000027$$

$$114. 6.378 \times 10^8 = 637,800,000$$

$$116. 7.6 \times 10^4 = 76,000$$

$$118. 1.66 \times 10^{-5} = 0.0000166$$

$$120. 8.007 \times 10^8 = 800,700,000$$

$$122. 3.949 \times 10^6 = 3,949,000$$

$$124. 6.68 \times 10^{-2} = 0.0668$$

$$126. 6.8 \times 10^7 = 68,000,000$$

$$128. \text{ answers may vary}$$

$$130. \text{ answers may vary}$$

Section 1.7 Practice Exercises

$$1. (y^2)^8 = y^{2 \cdot 8} = y^{16}$$

$$2. (3^3)^2 = 3^{3 \cdot 2} = 3^6 = 729$$

$$3. (6^2)^{-1} = 6^{2 \cdot (-1)} = 6^{-2} = \frac{1}{6^2} = \frac{1}{36}$$

$$4. (x^{-5})^{-7} = x^{-5 \cdot (-7)} = x^{35}$$

$$5. (3x^4)^3 = 3^3 \cdot (x^4)^3 = 3^3 \cdot x^{4 \cdot 3} = 27x^{12}$$

$$6. \left(\frac{4}{5}\right)^2 = \frac{4^2}{5^2} = \frac{16}{25}$$

$$7. \left(\frac{4m^5}{n^3}\right)^3 = \frac{(4m^5)^3}{(n^3)^3} = \frac{4^3 \cdot (m^5)^3}{(n^3)^3} = \frac{64m^{15}}{n^9}$$

$$8. \left(\frac{2^{-1}}{y}\right)^{-3} = \frac{(2^{-1})^{-3}}{y^{-3}} = \frac{2^3}{y^{-3}} = 8y^3$$

$$\begin{aligned} 9. (a^{-4}b^3c^{-2})^6 &= (a^{-4})^6 \cdot (b^3)^6 \cdot (c^{-2})^6 \\ &= a^{-24}b^{18}c^{-12} \\ &= \frac{b^{18}}{a^{24}c^{12}} \end{aligned}$$

$$\begin{aligned} 10. (7xy^{-2})^{-2} &= 7^{-2}(x)^{-2}(y^{-2})^{-2} \\ &= 7^{-2}x^{-2}y^4 \\ &= \frac{y^4}{7^2x^2} \\ &= \frac{y^4}{49x^2} \end{aligned}$$

$$\begin{aligned} 11. \left(\frac{y^{-7}}{y^{-10}}\right)^{-3} &= \frac{(y^{-7})^{-3}}{(y^{-10})^{-3}} \\ &= \frac{y^{21}}{y^{30}} \\ &= y^{21-30} \\ &= y^{-9} \\ &= \frac{1}{y^9} \end{aligned}$$

$$12. \left(\frac{3}{5}\right)^{-2} = \frac{3^{-2}}{5^{-2}} = \frac{5^2}{3^2} = \frac{25}{9}$$

$$\begin{aligned} 13. \frac{6^{-2}x^{-4}y^{10}}{x^2y^{-6}} &= 6^{-2}x^{-4-2}y^{10-(-6)} \\ &= 6^{-2}x^{-6}y^{16} \\ &= \frac{y^{16}}{6^2x^6} \\ &= \frac{y^{16}}{36x^6} \end{aligned}$$

$$\begin{aligned} 14. \left(\frac{4a^3b^2}{b^{-6}c}\right)^{-2} &= \left(\frac{4a^3b^8}{c}\right)^{-2} \\ &= \frac{4^{-2}a^{-6}b^{-16}}{c^{-2}} \\ &= \frac{c^2}{4^2a^6b^{16}} \\ &= \frac{c^2}{16a^6b^{16}} \end{aligned}$$

$$\begin{aligned} 15. \left(\frac{4x^3}{3y^{-1}}\right)^3 \left(\frac{y^{-2}}{3x^{-1}}\right)^{-1} &= \frac{64x^9}{27y^{-3}} \cdot \frac{y^2}{3^{-1}x^1} \\ &= \frac{64 \cdot 3 \cdot x^9 \cdot y^2 \cdot y^3}{27x^1} \\ &= \frac{64x^8y^5}{9} \end{aligned}$$

$$16. x^{-n}(3x^n)^2 = x^{-n}3^2x^{2n} = 9x^{-n+2n} = 9x^n$$

$$\begin{aligned} 17. \frac{(y^{2m})^2}{y^{m-3}} &= \frac{y^{2m \cdot 2}}{y^{m-3}} \\ &= \frac{y^{4m}}{y^{m-3}} \\ &= y^{4m-(m-3)} \\ &= y^{4m-m+3} \\ &= y^{3m+3} \end{aligned}$$

$$\begin{aligned} 18. (9.6 \times 10^6)(4 \times 10^{-8}) &= 9.6 \times 4 \times 10^6 \times 10^{-8} \\ &= 38.4 \times 10^{-2} \\ &= (3.84 \times 10^1) \times 10^{-2} \\ &= 3.84 \times 10^{-1} \end{aligned}$$

$$\begin{aligned}
 19. \quad \frac{4.2 \times 10^7}{7 \times 10^{-3}} &= \left(\frac{4.2}{7} \right) \left(\frac{10^7}{10^{-3}} \right) \\
 &= 0.6 \times 10^{7-(-3)} \\
 &= 0.6 \times 10^{10} \\
 &= (6 \times 10^{-1})(10^{10}) \\
 &= 6 \times 10^9
 \end{aligned}$$

$$\begin{aligned}
 20. \quad \frac{3000 \times 0.000012}{400} &= \frac{(3 \times 10^3)(1.2 \times 10^{-5})}{4 \times 10^2} \\
 &= \frac{3(1.2)}{4} \cdot \frac{10^3 \cdot 10^{-5}}{10^2} \\
 &= 0.9 \times 10^{-4} \\
 &= (9 \times 10^{-1}) \times 10^{-4} \\
 &= 9 \times 10^{-5}
 \end{aligned}$$

Vocabulary, Readiness & Video Check 1.7

1. $(x^4)^5 = x^{4 \cdot 5} = x^{20}$
2. $(5^6)^2 = 5^{6 \cdot 2} = 5^{12}$
3. $x^4 \cdot x^5 = x^{4+5} = x^9$
4. $x^7 \cdot x^8 = x^{7+8} = x^{15}$
5. $(y^6)^7 = y^{6 \cdot 7} = y^{42}$
6. $(x^3)^4 = x^{3 \cdot 4} = x^{12}$
7. $(z^4)^9 = z^{4 \cdot 9} = z^{36}$
8. $(z^3)^7 = z^{3 \cdot 7} = z^{21}$
9. $(z^{-6})^{-3} = z^{-6(-3)} = z^{18}$
10. $(y^{-4})^{-2} = y^{-4(-2)} = y^8$
11. The power rule involves a power of a base raised to a power and exponents are multiplied; the product rule involves a product of like bases and exponents are added.
12. power of a quotient, power of a product, power rule, negative exponent, quotient rule
13. multiplied

14. We are asked to write the answer in scientific notation. The first product isn't because the number multiplied by the power of 10 is not between 1 and 10.

Exercise Set 1.7

2. $(2^{-2})^2 = 2^{-4} = \frac{1}{2^4} = \frac{1}{16}$
4. $(y^7)^{-3} = y^{-21} = \frac{1}{y^{21}}$
6. $(4x^3yz)^2 = 4^2(x^3)^2y^2z^2 = 16x^6y^2z^2$
8. $\left(\frac{3a^{-4}}{b^7} \right)^3 = \frac{3^3(a^{-4})^3}{(b^7)^3} = \frac{27a^{-12}}{b^{21}} = \frac{27}{a^{12}b^{21}}$
10. $(6x^{-6}y^7z^0)^{-2} = 6^{-2}(x^{-6})^{-2}(y^7)^{-2}(z^0)^{-2}$
 $= 6^{-2}x^{12}y^{-14}z^0$
 $= \frac{x^{12}}{6^2y^{14}}$
 $= \frac{x^{12}}{36y^{14}}$
12. $\left(\frac{a^{-2}b^{-5}}{c^{-11}} \right)^{-6} = \frac{a^{-2(-6)}b^{-5(-6)}}{c^{-11(-6)}} = \frac{a^{12}b^{30}}{c^{66}}$
14. $(-4^{-6}y^{-6})^{-4} = [-1 \cdot (4)^{-6}y^{-6}]^{-4}$
 $= (-1)^{-4}(4^{-6})^{-4}(y^{-6})^{-4}$
 $= 1 \cdot 4^{24}y^{24}$
 $= 4^{24}y^{24}$
16. $\left(\frac{x^{-9}}{x^{-4}} \right)^{-3} = (x^{-9-(-4)})^3 = (x^{-5})^{-3} = x^{15}$
18. $\left(\frac{4p^6}{p^9} \right)^3 = (4p^{6-9})^3 = (4p^{-3})^3 = 4^3p^{-9} = \frac{64}{p^9}$

$$\begin{aligned}
 20. \quad (-5y^0x^2a^3)^{-3} &= [-1 \cdot 5y^0x^2a^3]^{-3} \\
 &= (-1)^{-3} \cdot 5^{-3}y^0x^{-6}a^{-9} \\
 &= -\frac{1}{5^3a^9x^6} \\
 &= -\frac{1}{125a^9x^6}
 \end{aligned}$$

$$22. \quad \left(\frac{5}{8}\right)^{-2} = \frac{5^{-2}}{8^{-2}} = \frac{8^2}{5^2} = \frac{64}{25}$$

$$\begin{aligned}
 24. \quad \left(\frac{5x^7y^4}{10x^3y^{-2}}\right)^{-3} &= \left(\frac{1}{2}x^4y^6\right)^{-3} \\
 &= \left(\frac{1}{2}\right)^{-3}x^{-12}y^{-18} \\
 &= \frac{1^{-3}x^{-12}y^{-18}}{2^{-3}} \\
 &= \frac{2^3}{1^3x^{12}y^{18}} \\
 &= \frac{8}{x^{12}y^{18}}
 \end{aligned}$$

$$26. \quad \left(\frac{x^{-1}y^{-2}}{z^{-3}}\right)^{-5} = \frac{(x^{-1})^{-5}(y^{-2})^{-5}}{(z^{-3})^{-5}} = \frac{x^5y^{10}}{z^{15}}$$

$$28. \quad (z^{-2})^{13} = z^{-2 \cdot 13} = z^{-26} = \frac{1}{z^{26}}$$

$$30. \quad (8^2)^{-1} = 8^{-2} = \frac{1}{8^2} = \frac{1}{64}$$

$$32. \quad (y^{-4})^5 = y^{-4 \cdot 5} = y^{-20} = \frac{1}{y^{20}}$$

$$34. \quad \left(\frac{a^{-3}}{b^{-6}}\right)^{-4} = \frac{(a^{-3})^{-4}}{(b^{-6})^{-4}} = \frac{a^{12}}{b^{24}}$$

$$36. \quad (-8x^3)^2 = [(-1) \cdot 8x^3]^2 = (-1)^2 \cdot 8^2 \cdot x^6 = 64x^6$$

$$38. \quad \left(\frac{7^{-3}}{ab^2}\right)^{-2} = \frac{(7^{-3})^{-2}}{a^{-2}(b^2)^{-2}} = \frac{7^6}{a^{-2}b^{-4}} = 7^6a^2b^4$$

$$\begin{aligned}
 40. \quad \left(\frac{n^5}{2m^{-2}}\right)^{-4} &= \frac{(n^5)^{-4}}{2^{-4}(m^{-2})^{-4}} \\
 &= \frac{n^{-20}}{2^{-4}m^8} \\
 &= \frac{2^4}{m^8n^{20}} \\
 &= \frac{16}{m^8n^{20}}
 \end{aligned}$$

$$\begin{aligned}
 42. \quad \frac{8^{-2}x^{-3}y^{11}}{x^2y^{-5}} &= 8^{-2}x^{-3-2}y^{11-(-5)} \\
 &= 8^{-2}x^{-5}y^{16} \\
 &= \frac{y^{16}}{8^2x^5} \\
 &= \frac{y^{16}}{64x^5}
 \end{aligned}$$

$$44. \quad \left(\frac{8^{-3}}{y^2}\right)^{-2} = \frac{8^6}{y^{-4}} = 8^6y^4$$

$$46. \quad \frac{2(y^3)^{-3}}{y^{-3}} = \frac{2y^{-9}}{y^{-3}} = 2y^{-9-(-3)} = 2y^{-6} = \frac{2}{y^6}$$

$$\begin{aligned}
 48. \quad \frac{2^{-3}m^{-4}n^{-5}}{5^{-2}m^{-5}n} &= \left(\frac{2^{-3}}{5^{-2}}\right)m^{-4-(-5)}n^{-5-1} \\
 &= \frac{5^2}{2^3}mn^{-6} \\
 &= \frac{25m}{8n^6}
 \end{aligned}$$

$$\begin{aligned}
 50. \quad (5x^2y^4)^{-2}(3x^9y^4) &= 5^{-2}(x^2)^{-2}(y^4)^{-2} \cdot 3x^9y^4 \\
 &= \frac{1}{5^2}x^{-4}y^{-8} \cdot 3x^9y^4 \\
 &= \frac{3}{25}x^{-4+9}y^{-8+4} \\
 &= \frac{3}{25}x^5y^{-4} \\
 &= \frac{3x^5}{25y^4}
 \end{aligned}$$

$$\begin{aligned}
 67. \quad & \frac{25x^{2a+b}y^{2a-b}}{5x^{a-b}y^{a+b}} \\
 &= \left(\frac{25}{5}\right)x^{2a+b-(a-b)}y^{2a-b-(a+b)} \\
 &= 5x^{a+2b}y^{a-2b}
 \end{aligned}$$

$$\begin{aligned}
 69. \quad & (5 \times 10^{11})(2.9 \times 10^{-3}) = 5 \times 2.9 \times 10^{11} \times 10^{-3} \\
 &= 14.5 \times 10^8 \\
 &= (1.45 \times 10^1) \times 10^8 \\
 &= 1.45 \times 10^9
 \end{aligned}$$

$$71. \quad (2 \times 10^5)^3 = 2^3 \times (10^5)^3 = 8 \times 10^{15}$$

$$\begin{aligned}
 73. \quad & \frac{3.6 \times 10^{-4}}{9 \times 10^2} = \frac{3.6}{9} \cdot \frac{10^{-4}}{10^2} \\
 &= 0.4 \times 10^{-6} \\
 &= (4 \times 10^{-1}) \times 10^{-6} \\
 &= 4 \times 10^{-7}
 \end{aligned}$$

$$75. \quad \frac{0.0069}{0.023} = \frac{6.9 \times 10^{-3}}{2.3 \times 10^{-2}} = \frac{6.9}{2.3} \cdot \frac{10^{-3}}{10^{-2}} = 3 \times 10^{-1}$$

$$\begin{aligned}
 77. \quad & \frac{18,200 \times 100}{91,000} = \frac{1.82 \times 10^4 \times 10^2}{9.1 \times 10^4} \\
 &= \frac{1.82}{9.1} \cdot \frac{10^6}{10^4} \\
 &= 0.2 \times 10^2 \\
 &= (2 \times 10^{-1}) \times 10^2 \\
 &= 2 \times 10^1
 \end{aligned}$$

$$\begin{aligned}
 79. \quad & \frac{6000 \times 0.006}{0.009 \times 400} = \frac{6 \times 10^3 \times 6 \times 10^{-3}}{9 \times 10^{-3} \times 4 \times 10^2} \\
 &= \frac{36 \times 10^0}{36 \times 10^{-1}} \\
 &= \frac{36}{36} \cdot \frac{10^0}{10^{-1}} \\
 &= 1 \times 10^1
 \end{aligned}$$

$$\begin{aligned}
 81. \quad & \frac{0.00064 \times 2000}{16,000} = \frac{6.4 \times 10^{-4} \times 2 \times 10^3}{1.6 \times 10^4} \\
 &= \frac{12.8 \times 10^{-1}}{1.6 \times 10^4} \\
 &= \frac{12.8}{1.6} \cdot \frac{10^{-1}}{10^4} \\
 &= 8 \times 10^{-5}
 \end{aligned}$$

$$\begin{aligned}
 83. \quad & \frac{66,000 \times 0.001}{0.002 \times 0.003} = \frac{6.6 \times 10^4 \times 1 \times 10^{-3}}{2 \times 10^{-3} \times 3 \times 10^{-3}} \\
 &= \frac{6.6 \times 10^1}{6 \times 10^{-6}} \\
 &= \frac{6.6}{6} \cdot \frac{10^1}{10^{-6}} \\
 &= 1.1 \times 10^7
 \end{aligned}$$

$$\begin{aligned}
 85. \quad & \frac{9.24 \times 10^{15}}{(2.2 \times 10^{-2})(1.2 \times 10^{-5})} \\
 &= \frac{9.24}{(2.2)(1.2)} \cdot \frac{10^{15}}{10^{-2} \cdot 10^{-5}} \\
 &= \frac{9.24}{2.64} \times 10^{22} \\
 &= 3.5 \times 10^{22}
 \end{aligned}$$

$$\begin{aligned}
 87. \quad & (6.452 \times 10^{-4})(4 \times 10^{-2}) = 25.808 \times 10^{-6} \\
 &= (2.5808 \times 10^1) \times 10^{-6} \\
 &= 2.5808 \times 10^{-5}
 \end{aligned}$$

The area of the square is 2.5808×10^{-5} square meter.

$$89. \quad \text{The volume of a cube is (side)}^3.$$

The volume of the given cube is

$$\begin{aligned}
 \left(\frac{2x^{-2}}{y}\right)^3 &= \frac{2^3(x^{-2})^3}{y^3} \\
 &= \frac{8x^{-6}}{y^3} \\
 &= \frac{8}{x^6 y^3} \text{ cubic meters.}
 \end{aligned}$$

91. Since $D = \frac{M}{V}$ and $M = 500,000$ and $V = 250$,

$$D = \frac{500,000}{250}$$

$$D = \frac{5 \times 10^5}{2.5 \times 10^2} = \frac{5}{2.5} \cdot \frac{10^5}{10^2} = 2 \times 10^3$$

The density of an object whose mass is 500,000 pounds and whose volume is 250 cubic feet is 2×10^3 pounds per cubic feet.

93. Yes; $a = \pm 1$

95. No; answers may vary.

97. $\frac{3.17 \times 10^8}{3.536 \times 10^6} = \frac{3.17}{3.536} \times \frac{10^8}{10^6} \approx 0.90 \times 10^2 = 90$

The population density of the U.S. in 2014 was 90 people per square mile.

99. $\frac{2.37 \times 10^{11}}{3.17 \times 10^8} = \frac{2.37}{3.17} \times \frac{10^{11}}{10^8} \approx 0.748 \times 10^3 = 748$

The average value of imports was \$748 per person.

Chapter 1 Vocabulary Check

1. An algebraic expression is formed by numbers and variables connected by the operations of addition, subtraction, multiplication, division, raising to powers, and/or taking roots.
2. The opposite of a number a is $-a$.
3. $3(x - 6) = 3x - 18$ by the distributive property.
4. The absolute value of a number is the distance between that number and 0 on a number line.
5. An exponent is a shorthand notation for repeated multiplication of the same factor.
6. A letter that represents a number is called a variable.
7. The symbols $<$ and $>$ are called inequality symbols.
8. If a is not 0, then a and $\frac{1}{a}$ are called reciprocals.
9. $A + B = B + A$ by the commutative property of addition.

10. $(A + B) + C = A + (B + C)$ by the associative property of addition.

11. The numbers 0, 1, 2, 3, ... are called whole numbers.

12. If a number corresponds to a point on a number line, we know that number is a real number.

Chapter 1 Review

1. The quotient of a number and seven is written as $\frac{x}{7}$.
2. The product of a number and seven is written as $7x$.
3. Four times the sum of a number and ten is written as $4(x + 10)$.
4. The difference of three times a number and nine is written as $3x - 9$.
5. $\{x|x \text{ is an odd integer between } -2 \text{ and } 4\}$
 $= \{-1, 1, 3\}$
6. $\{x|x \text{ is an even integer between } -3 \text{ and } 7\}$
 $= \{-2, 0, 2, 4, 6\}$
7. $\{x|x \text{ is a negative whole number}\} = \{ \}$ or \emptyset
8. $\{x|x \text{ is a natural number that is not a rational number}\} = \{ \}$ or \emptyset
9. $\{x|x \text{ is a whole number greater than } 5\}$
 $= \{6, 7, 8, \dots\}$
10. $\{x|x \text{ is an integer less than } 3\} = \{\dots, -1, 0, 1, 2\}$
11. Since 10 is an element of D , $10 \in D$ is true.
12. Since 59 is not an element of B , $59 \in B$ is false.
13. Since $\sqrt{169} = 13$ is not an element of A , $\sqrt{169} \notin A$ is true.
14. Since 0 is not an element of F , $0 \notin F$ is true.
15. Since π is not an element of E , $\pi \in E$ is false.
16. Since π is an element of H , $\pi \in H$ is true.
17. Since $\sqrt{4} = 2$ is not an element of G , $\sqrt{4} \in G$ is false.

18. Since -9 is an element of C , $-9 \in C$ is true.
19. The whole numbers in the set are $\left\{5, \frac{8}{2}, \sqrt{9}\right\}$.
20. The natural numbers in the set are $\left\{5, \frac{8}{2}, \sqrt{9}\right\}$.
21. The rational numbers in the set are $\left\{5, -\frac{2}{3}, \frac{8}{2}, \sqrt{9}, 0.3, 1\frac{5}{8}, -1\right\}$.
22. The irrational numbers in the set are $\{\sqrt{7}, \pi\}$.
23. The real numbers in the set are $\left\{5, -\frac{2}{3}, \frac{8}{2}, \sqrt{9}, 0.3, \sqrt{7}, 1\frac{5}{8}, -1, \pi\right\}$.
24. The integers in the set are $\left\{5, \frac{8}{2}, \sqrt{9}, -1\right\}$.
25. Twelve is the product of x and negative 4 is written as $12 = -4x$.
26. The sum of n and twice n is negative fifteen is written as $n + 2n = -15$.
27. Four times the sum of y and three is -1 is written as $4(y + 3) = -1$.
28. The difference of t and five, multiplied by six is four is written as $6(t - 5) = 4$.
29. Seven subtracted from z is six is written as $z - 7 = 6$.
30. Ten less than the product of x and nine is five is written as $9x - 10 = 5$.
31. The difference of x and 5 is the same as 12 is written as $x - 5 = 12$.
32. The opposite of four is equal to the product of y and seven is written as $-4 = 7y$.
33. Two-thirds is equal to twice the sum of n and one-fourth is written as $\frac{2}{3} = 2\left(n + \frac{1}{4}\right)$.
34. The sum of t and six amounts to negative twelve is written as $t + 6 = -12$.
35. The opposite of $-\frac{3}{4}$ is $\frac{3}{4}$.
36. The opposite of 0.6 is -0.6 .
37. The opposite of 0 is 0.
38. The opposite of -1 is 1.
39. The reciprocal of $-\frac{3}{4}$ is $-\frac{4}{3}$.
40. The reciprocal of $\frac{1}{5}$ is 5.
41. The reciprocal of 0 is undefined.
42. The reciprocal of -1 is -1 .
43. $(M + 5) + P = M + (5 + P)$ by the associative property of addition.
44. $5(3x - 4) = 15x - 20$ by the distributive property.
45. $(-4) + 4 = 0$ by the additive inverse property.
46. $(3 + x) + 7 = 7 + (3 + x)$ by the commutative property of addition.
47. $(XY)Z = X(YZ)$ by the associative property of multiplication.
48. $\left(-\frac{3}{5}\right) \cdot \left(-\frac{5}{3}\right) = 1$ by the multiplicative inverse property.
49. $T \cdot 1 = T$ by the multiplicative identity property.
50. $(x + y) + z = (y + x) + z$ by the commutative property of addition.
51. $A + 0 = A$ by the additive identity property.
52. $8 \cdot 1 = 8$ by the multiplicative identity property.
53. $5(x - 3z) = 5x - 15z$ by the distributive property.
54. $(7 + y) + (3 + x) = (3 + x) + (7 + y)$, for example, by the commutative property.
55. $0 = 2 + (-2)$, for example, by the additive inverse property.

56. $1 = 2 \cdot \frac{1}{2}$, for example, by the multiplicative inverse property.

57. $[(3.4)(0.7)]5 = (3.4)[(0.7)5]$ by the associative property.

58. $7 = 7 + 0$ by the additive identity property.

59. $-9 > -12$, since -9 is to the right of -12 .

60. $0 > -6$, since 0 is to the right of -6 .

61. $-3 < -1$, since -3 is to the left of -1 .

62. $7 = |-7|$, since $|-7| = 7$ and $7 = 7$.

63. $-5 < -(-5)$, since $-(-5) = 5$ and -5 is to the left of 5 .

64. $-(-2) > -2$, since $-(-2) = 2$ and 2 is to the right of -2 .

65. $-3(2x - 7y) = -3 \cdot 2x - (-3) \cdot 7y$
 $= -6x - (-21y)$
 $= -6x + 21y$

66. $-9(10a + 4b) = -9 \cdot 10a + (-9) \cdot 4b$
 $= -90a + (-36b)$
 $= -90a - 36b$

67. $\frac{1}{2}(18m - 8n + 1) = \frac{1}{2} \cdot 18m - \frac{1}{2} \cdot 8n + \frac{1}{2} \cdot 1$
 $= 9m - 4n + \frac{1}{2}$

68. $\frac{1}{3}(12x - 33y + 2) = \frac{1}{3} \cdot 12x - \frac{1}{3} \cdot 33y + \frac{1}{3} \cdot 2$
 $= 4x - 11y + \frac{2}{3}$

69. $-7 + 3 = -4$

70. $-10 + (-25) = -35$

71. $5(-0.4) = -2$

72. $(-3.1)(-0.1) = 0.31$

73. $-7 - (-15) = -7 + 15 = 8$

74. $9 - (-4.3) = 9 + 4.3 = 13.3$

75. $\sqrt{16} - 2^3 = 4 - 8 = 4 + (-8) = -4$

76. $\sqrt[3]{27} - 5^2 = 3 - 25 = 3 + (-25) = -22$

77. $-24 \div 0$ is undefined.

78. $0 \div (-45) = 0$

79. $(-36) \div (-9) = 4$

80. $60 \div (-12) = -5$

81. $-\frac{4}{5} - \left(-\frac{2}{3}\right) = -\frac{4}{5} + \frac{2}{3}$
 $= -\frac{4}{5} \cdot \frac{3}{3} + \frac{2}{3} \cdot \frac{5}{5}$
 $= -\frac{12}{15} + \frac{10}{15}$
 $= -\frac{2}{15}$

82. $\frac{5}{4} - \left(-\frac{3}{4}\right) = \frac{5}{4} + \frac{3}{4} = \frac{8}{4} = 2$

83. $1 - \frac{1}{4} - \frac{1}{3} = \frac{12}{12} - \frac{3}{12} - \frac{4}{12} = \frac{5}{12}$

84. $31,441 - 1589 = 29,852$ feet below sea level

85. $-5 + 7 - 3 - (-10) = 2 - 3 - (-10)$
 $= -1 - (-10)$
 $= -1 + 10$
 $= 9$

86. $8 - (-3) + (-4) + 6 = 8 + 3 + (-4) + 6$
 $= 11 + (-4) + 6$
 $= 7 + 6$
 $= 13$

87. $3(4 - 5)^4 = 3(-1)^4 = 3(1) = 3$

88. $6(7 - 10)^2 = 6(-3)^2 = 6(9) = 54$

89. $\left(-\frac{8}{15}\right) \cdot \left(-\frac{2}{3}\right)^2 = \left(-\frac{8}{15}\right) \left(\frac{4}{9}\right) = -\frac{32}{135}$

90. $\left(-\frac{3}{4}\right)^2 \cdot \left(-\frac{10}{21}\right) = \left(\frac{9}{16}\right) \left(-\frac{10}{21}\right) = -\frac{90}{336} = -\frac{15}{56}$

$$91. -\frac{6}{15} \div \frac{8}{25} = -\frac{6}{15} \cdot \frac{25}{8} = -\frac{150}{120} = -\frac{5}{4}$$

$$92. \frac{4}{9} \div \left(-\frac{8}{45}\right) = \frac{4}{9} \cdot \left(-\frac{45}{8}\right) = -\frac{180}{72} = -\frac{5}{2}$$

$$\begin{aligned} 93. -\frac{3}{8} + 3(2) \div 6 &= -\frac{3}{8} + 6 \div 6 \\ &= -\frac{3}{8} + 1 \\ &= -\frac{3}{8} + \frac{8}{8} \\ &= \frac{5}{8} \end{aligned}$$

$$\begin{aligned} 94. 5(-2) - (-3) - \frac{1}{6} + \frac{2}{3} &= -10 - (-3) - \frac{1}{6} + \frac{2}{3} \\ &= -10 + 3 - \frac{1}{6} + \frac{2}{3} \\ &= -7 - \frac{1}{6} + \frac{2}{3} \\ &= -\frac{42}{6} - \frac{1}{6} + \frac{4}{6} \\ &= -\frac{39}{6} \\ &= -\frac{13}{2} \end{aligned}$$

$$\begin{aligned} 95. |2^3 - 3^2| - |5 - 7| &= |8 - 9| - |5 - 7| \\ &= |-1| - |-2| \\ &= 1 - 2 \\ &= -1 \end{aligned}$$

$$\begin{aligned} 96. |5^2 - 2^2| + |9 \div (-3)| &= |25 - 4| + |9 \div (-3)| \\ &= |21| + |-3| \\ &= 21 + 3 \\ &= 24 \end{aligned}$$

$$\begin{aligned} 97. (2^3 - 3^2) - (5 - 7) &= (8 - 9) - (5 - 7) \\ &= -1 - (-2) \\ &= -1 + 2 \\ &= 1 \end{aligned}$$

$$\begin{aligned} 98. (5^2 - 2^2) + [9 \div (-3)] &= (25 - 4) + [9 \div (-3)] \\ &= 21 + [-3] \\ &= 18 \end{aligned}$$

$$\begin{aligned} 99. \frac{(8-10)^3 - (-4)^2}{2+8(2) \div 4} &= \frac{(-2)^3 - 16}{2+16 \div 4} \\ &= \frac{-8-16}{2+4} \\ &= \frac{-24}{6} \\ &= -4 \end{aligned}$$

$$\begin{aligned} 100. \frac{(2+4)^2 + (-1)^5}{12 \div 2 \cdot 3 - 3} &= \frac{6^2 + (-1)}{6 \cdot 3 - 3} \\ &= \frac{36 + (-1)}{18 - 3} \\ &= \frac{35}{15} \\ &= \frac{7}{3} \end{aligned}$$

$$\begin{aligned} 101. \frac{(4-9) + 4 - 9}{10 - 12 \div 4 \cdot 8} &= \frac{-5 + 4 - 9}{10 - 3 \cdot 8} \\ &= \frac{-1 - 9}{10 - 24} \\ &= \frac{-10}{-14} \\ &= \frac{5}{7} \end{aligned}$$

$$102. \frac{3 - 7 - (7 - 3)}{15 + 30 \div 6 \cdot 2} = \frac{3 - 7 - 4}{15 + 5 \cdot 2} = \frac{-4 - 4}{15 + 10} = -\frac{8}{25}$$

$$103. \frac{\sqrt{25}}{4 + 3 \cdot 7} = \frac{5}{4 + 21} = \frac{5}{25} = \frac{1}{5}$$

$$104. \frac{\sqrt{64}}{24 - 8 \cdot 2} = \frac{8}{24 - 16} = \frac{8}{8} = 1$$

105.	Radius, r	Circumference, $2\pi r$
	1	$2(3.14)(1) = 6.28$
	10	$2(3.14)(10) = 62.8$
	100	$2(3.14)(100) = 628$

106. As the radius of the circle increases, the circumference increases.

$$107. 14x - 3 - 11x - 10 = 14x - 11x - 3 - 10 = 3x - 13$$

$$108. 81y + 19 - y - 20 = 81y - y + 19 - 20 = 80y - 1$$

$$109. \quad 7a - 3(2a - y) + 4y - 6 = 7a - 6a + 3y + 4y - 6 \\ = a + 7y - 6$$

$$110. \quad 9b - 4(8b - x) + 9x - 10 = 9b - 32b + 4x + 9x - 10 \\ = -23b + 13x - 10$$

$$111. \quad \frac{1}{5}(15m - 5n) - (3m - 5) + 2n \\ = 3m - n - 3m + 5 + 2n \\ = 3m - 3m - n + 2n + 5 \\ = n + 5$$

$$112. \quad -(2x - 9) + \frac{1}{4}(8x + 4y) - 13 \\ = -2x + 9 + 2x + y - 13 \\ = -2x + 2x + y + 9 - 13 \\ = y - 4$$

$$113. \quad (-2)^2 = (-2)(-2) = 4$$

$$114. \quad (-3)^4 = (-3)(-3)(-3)(-3) = 81$$

$$115. \quad -2^2 = -1(2 \cdot 2) = -4$$

$$116. \quad -3^4 = -1(3 \cdot 3 \cdot 3 \cdot 3) = -81$$

$$117. \quad 8^0 = 1$$

$$118. \quad -9^0 = -(9^0) = -1$$

$$119. \quad -4^{-2} = -(4^{-2}) = -\left(\frac{1}{4^2}\right) = -\left(\frac{1}{16}\right) = -\frac{1}{16}$$

$$120. \quad (-4)^{-2} = \frac{1}{(-4)^2} = \frac{1}{16}$$

$$121. \quad -xy^2 \cdot y^3 \cdot xy^2z = -1x^1x^1y^2y^3y^2z \\ = -1 \cdot x^{1+1} \cdot y^{2+3+2} \cdot z \\ = -x^2y^7z$$

$$122. \quad (-4xy)(-3xy^2b) = (-4)(-3)x^1x^1y^1y^2b \\ = 12x^{1+1}y^{1+2}b \\ = 12x^2y^3b$$

$$123. \quad a^{-14} \cdot a^5 = a^{-14+5} = a^{-9} = \frac{1}{a^9}$$

$$124. \quad \frac{a^{16}}{a^{17}} = a^{16-17} = a^{-1} = \frac{1}{a^1} = \frac{1}{a}$$

$$125. \quad \frac{x^{-7}}{x^4} = x^{-7-4} = x^{-11} = \frac{1}{x^{11}}$$

$$126. \quad \frac{9a(a^{-3})}{18a^{15}} = \frac{9}{18} \cdot \frac{a^1 \cdot a^{-3}}{a^{15}} \\ = \frac{1}{2} \cdot \frac{a^{-2}}{a^{15}} \\ = \frac{1}{2} a^{-17} \\ = \frac{1}{2a^{17}}$$

$$127. \quad \frac{y^{6p-3}}{y^{6p+2}} = y^{6p-3-(6p+2)} = y^{-5} = \frac{1}{y^5}$$

$$128. \quad \frac{4y^{3x-3}}{2y^{2x+4}} = \frac{4}{2} \cdot y^{3x-3-(2x+4)} = 2y^{x-7}$$

$$129. \quad 36,890,000 = 3.689 \times 10^7$$

$$130. \quad 0.000362 = 3.62 \times 10^{-4}$$

$$131. \quad 1.678 \times 10^{-6} = 0.000001678$$

$$132. \quad 4.1 \times 10^5 = 410,000$$

$$133. \quad (8^5)^3 = 8^{5 \cdot 3} = 8^{15}$$

$$134. \quad \left(\frac{a}{4}\right)^2 = \frac{a^2}{4^2} = \frac{a^2}{16}$$

$$135. \quad (3x)^3 = 3^3x^3 = 27x^3$$

$$136. \quad (-4x)^{-2} = (-4)^{-2}x^{-2} = \frac{1}{(-4)^2} \cdot \frac{1}{x^2} = \frac{1}{16x^2}$$

$$137. \quad \left(\frac{6x}{5}\right)^2 = \frac{(6x)^2}{5^2} = \frac{6^2x^2}{5^2} = \frac{36x^2}{25}$$

$$138. \quad (8^6)^{-3} = 8^{6 \cdot -3} = 8^{-18} = \frac{1}{8^{18}}$$

$$139. \left(\frac{4}{3}\right)^{-2} = \frac{4^{-2}}{3^{-2}} = \frac{3^2}{4^2} = \frac{9}{16}$$

$$\begin{aligned} 140. (-2x^3)^{-3} &= (-1 \cdot 2x^3)^{-3} \\ &= (-1)^{-3} 2^{-3} (x^3)^{-3} \\ &= \frac{1}{(-1)^3} \cdot \frac{1}{2^3} \cdot x^{-9} \\ &= -1 \cdot \frac{1}{8} \cdot x^{-9} \\ &= -\frac{1}{8x^9} \end{aligned}$$

$$\begin{aligned} 141. \left(\frac{8p^6}{4p^4}\right)^{-2} &= \left(\frac{8}{4} \cdot p^{6-4}\right)^{-2} \\ &= (2p^2)^{-2} \\ &= 2^{-2} (p^2)^{-2} \\ &= \frac{1}{2^2} p^{-4} \\ &= \frac{1}{2^2 p^4} \\ &= \frac{1}{4p^4} \end{aligned}$$

$$\begin{aligned} 142. (-3x^{-2}y^2)^3 &= (-1 \cdot 3x^{-2}y^2)^3 \\ &= (-1)^3 (3)^3 (x^{-2})^3 (y^2)^3 \\ &= -1 \cdot 27x^{-6}y^6 \\ &= -\frac{27y^6}{x^6} \end{aligned}$$

$$\begin{aligned} 143. \left(\frac{x^{-5}y^{-3}}{z^3}\right)^{-5} &= \frac{(x^{-5})^{-5} (y^{-3})^{-5}}{(z^3)^{-5}} \\ &= \frac{x^{25}y^{15}}{z^{-15}} \\ &= x^{25}y^{15}z^{15} \end{aligned}$$

$$\begin{aligned} 144. \frac{4^{-1}x^3yz}{x^{-2}yx^4} &= \frac{4^{-1}x^3yz}{x^2y} \\ &= 4^{-1}x^{3-2}y^{1-1}z \\ &= 4^{-1}x^1y^0z \\ &= \frac{xz}{4} \end{aligned}$$

$$\begin{aligned} 145. (5xyz)^{-4}(x^{-2})^{-3} &= 5^{-4}x^{-4}y^{-4}z^{-4}x^6 \\ &= 5^{-4}x^2y^{-4}z^{-4} \\ &= \frac{x^2}{5^4y^4z^4} \\ &= \frac{x^2}{625y^4z^4} \end{aligned}$$

$$\begin{aligned} 146. \frac{2(3yz)^{-3}}{y^{-3}} &= \frac{2 \cdot 3^{-3}y^{-3}z^{-3}}{y^{-3}} \\ &= 2 \cdot 3^{-3} \cdot y^{-3-(-3)} \cdot z^{-3} \\ &= 2 \cdot 3^{-3} \cdot y^0 \cdot z^{-3} \\ &= \frac{2}{3^3z^3} \\ &= \frac{2}{27z^3} \end{aligned}$$

$$\begin{aligned} 147. x^{4a}(3x^{5a})^3 &= x^{4a} \cdot 3^3(x^{5a})^3 \\ &= x^{4a} \cdot 3^3 \cdot x^{15a} \\ &= x^{4a+15a} \cdot 3^3 \\ &= 27x^{19a} \end{aligned}$$

$$\begin{aligned} 148. (3x^{2a+b}y^{-3b})^2 &= 3^2(x^{2a+b})^2(y^{-3b})^2 \\ &= 9x^{4a+2b}y^{-6b} \\ &= \frac{9x^{4a+2b}}{y^{6b}} \end{aligned}$$

	Number	Opposite of Number	Reciprocal of Number
149.	$-\frac{3}{4}$	$\frac{3}{4}$	$-\frac{4}{3}$
150.	5	-5	$\frac{1}{5}$

$$\begin{aligned} 151. -2\left(5x + \frac{1}{2}\right) + 7.1 &= -2 \cdot 5x + (-2) \cdot \frac{1}{2} + 7.1 \\ &= -10x + (-1) + 7.1 \\ &= -10x + 6.1 \end{aligned}$$

$$152. \sqrt{36} \div 2 \cdot 3 = 6 \div 2 \cdot 3 = 3 \cdot 3 = 9$$

$$153. -\frac{7}{11} - \left(-\frac{1}{11}\right) = -\frac{7}{11} + \frac{1}{11} = -\frac{6}{11}$$

$$\begin{aligned}
 154. \quad 10 - (-1) + (-2) + 6 &= 10 + 1 + (-2) + 6 \\
 &= 11 + (-2) + 6 \\
 &= 9 + 6 \\
 &= 15
 \end{aligned}$$

$$\begin{aligned}
 155. \quad \left(-\frac{2}{3}\right)^3 \div \frac{10}{9} &= (-1)^3 \cdot \frac{2^3}{3^3} \div \frac{10}{9} \\
 &= -\frac{8}{27} \div \frac{10}{9} \\
 &= -\frac{8}{27} \cdot \frac{9}{10} \\
 &= -\frac{72}{270} \\
 &= -\frac{4}{15}
 \end{aligned}$$

$$\begin{aligned}
 156. \quad \frac{(3-5)^2 + (-1)^3}{1+2(3-(-1))^2} &= \frac{(-2)^2 + (-1)}{1+2(3+1)^2} \\
 &= \frac{4+(-1)}{1+2(4)^2} \\
 &= \frac{3}{1+2 \cdot 16} \\
 &= \frac{3}{1+32} \\
 &= \frac{3}{33} \\
 &= \frac{1}{11}
 \end{aligned}$$

$$\begin{aligned}
 157. \quad \frac{1}{3}(9x-3y) - (4x-1) + 4y &= 3x - y - 4x + 1 + 4y \\
 &= 3x - 4x - y + 4y + 1 \\
 &= -x + 3y + 1
 \end{aligned}$$

$$158. \quad -5^{-2} = -1 \cdot 5^{-2} = -1 \cdot \frac{1}{5^2} = -\frac{1}{25}$$

$$\begin{aligned}
 159. \quad \left(\frac{5x^7}{10x^{-3}}\right)^{-3} &= \left(\frac{1}{2}x^{10}\right)^{-3} \\
 &= \left(\frac{1}{2}\right)^{-3} (x^{10})^{-3} \\
 &= \frac{1^{-3}}{2^{-3}} x^{-30} \\
 &= \frac{2^3}{1^3} x^{-30} \\
 &= \frac{8}{x^{30}}
 \end{aligned}$$

$$\begin{aligned}
 160. \quad (-5a^{-2}bc)^{-2} \cdot (3a^{-3}b^2c^3)^2 \\
 &= (-1 \cdot 5a^{-2}bc)^{-2} (3a^{-3}b^2c^3)^2 \\
 &= (-1)^{-2} 5^{-2} (a^{-2})^{-2} b^{-2} c^{-2} \cdot 3^2 (a^{-3})^2 (b^2)^2 (c^3)^2 \\
 &= \frac{1}{(-1)^2} \cdot \frac{1}{5^2} a^4 b^{-2} c^{-2} \cdot 3^2 a^{-6} b^4 c^6 \\
 &= \frac{3^2}{5^2} a^{4+(-6)} b^{-2+4} c^{-2+6} \\
 &= \frac{9}{25} a^{-2} b^2 c^4 \\
 &= \frac{9b^2c^4}{25a^2}
 \end{aligned}$$

Chapter 1 Test

1. Since -2.3 is to the right of -2.33 , $-2.3 > -2.33$, so the statement is true.
2. Since $-6^2 = -36$ and $(-6)^2 = 36$, $-6^2 \neq (-6)^2$ so the statement is false.
3. Since $(-2)(-3)(0) = 0$ and $\frac{(-4)}{0}$ is undefined, $(-2)(-3)(0) \neq \frac{(-4)}{0}$, so the statement is false.
4. Since not all rational numbers are integers, the statement is false.
5. Since the set of natural numbers is contained in the set of integers, the statement is true.
6. $\{x|x \text{ is a whole number less than } 2\} = \{0, 1\}$
7. $5 - 12 \div 3(2) = 5 - 4(2) = 5 - 8 = -3$
8. $(4-9)^3 - |-4-6|^2 = (-5)^3 - |-10|^2$
 $= -125 - 10^2$
 $= -125 - 100$
 $= -225$
9. $[3|4-5|^5 - (-9)] \div (-6) = [3|-1|^5 - (-9)] \div (-6)$
 $= [3(1)^5 - (-9)] \div (-6)$
 $= [3 \cdot 1 - (-9)] \div (-6)$
 $= [3 - (-9)] \div (-6)$
 $= [3 + 9] \div (-6)$
 $= [12] \div (-6)$
 $= -2$

$$\begin{aligned}
 10. \quad \frac{6(7-9)^3 + (-2)}{(-2)(-5)(-5)} &= \frac{6(-2)^3 + (-2)}{(10)(-5)} \\
 &= \frac{6(-8) + (-2)}{-50} \\
 &= \frac{-48 + (-2)}{-50} \\
 &= \frac{-50}{-50} \\
 &= 1
 \end{aligned}$$

$$\begin{aligned}
 11. \quad \frac{(4 - \sqrt{16}) - (-7 - 20)}{-2(1-4)^2} &= \frac{(4-4) - (-27)}{-2(-3)^2} \\
 &= \frac{0+27}{-2(9)} \\
 &= \frac{27}{-18} \\
 &= -\frac{3}{2}
 \end{aligned}$$

12. Replace q with 4 and r with -2 .
 $q^2 - r^2 = 4^2 - (-2)^2 = 16 - 4 = 12$

13. Replace q with 4, r with -2 , and t with 1.
 $\frac{5t-3q}{3r-1} = \frac{5(1)-3(4)}{3(-2)-1} = \frac{5-12}{-6-1} = \frac{-7}{-7} = 1$

14. a.

Adults, x	Total Cost, $5.75x$
1	$5.75(1) = 5.75$
3	$5.75(3) = 17.25$
10	$5.75(10) = 57.50$
20	$5.75(20) = 115.00$

b. As the number of adults increases, the total cost increases.

15. Three times the quotient of n and five is the opposite of n is written as $3\left(\frac{n}{5}\right) = -n$.

16. Twenty is equal to six subtracted from twice x is written as $20 = 2x - 6$.

17. Negative two is equal to x divided by the sum of x and 5 is written as $-2 = \frac{x}{x+5}$.

18. $6(x-4) = 6x - 24$ by the distributive property.

19. $(4+x) + z = 4 + (x+z)$ by the associative property of addition.

20. $(-7) + 7 = 0$ by the additive inverse property.

21. The reciprocal of $-\frac{7}{11}$ is $-\frac{11}{7}$; the opposite of $-\frac{7}{11}$ is $\frac{7}{11}$.

22. $9x + 12y - 3x - 6.2 + 20$
 $= 9x - 3x + 12y - 6.2 + 20$
 $= 6x + 12y + 13.8$

23. $\frac{1}{3}(15x - 27y) - 2(3x - y) - 4y$
 $= 5x - 9y - 6x + 2y - 4y$
 $= 5x - 6x - 9y + 2y - 4y$
 $= -x - 11y$

24. $(-9x)^{-2} = (-1 \cdot 9x)^{-2}$
 $= (-1)^{-2} (9)^{-2} x^{-2}$
 $= \frac{1}{(-1)^2 (9)^2 x^2}$
 $= \frac{1}{81x^2}$

25. $\frac{6^{-1}a^2b^{-3}}{3^{-2}a^{-5}b^2} = \frac{3^2}{6^1}a^{2-(-5)}b^{-3-2} = \frac{9}{6}a^7b^{-5} = \frac{3a^7}{2b^5}$

26. $\left(\frac{-xy^{-5}z}{xy^3}\right)^{-5} = (-1x^{1-1}y^{-5-3}z^1)^{-5}$
 $= (-1x^0y^{-8}z^1)^{-5}$
 $= (-1y^{-8}z^1)^{-5}$
 $= (-1)^{-5}y^{40}z^{-5}$
 $= \frac{1}{(-1)^5} \cdot y^{40}z^{-5}$
 $= -1y^{40}z^{-5}$
 $= -\frac{y^{40}}{z^5}$

$$\begin{aligned}
 27. \quad & (-6a^{-5}b^{12})^{-2}(3ab^5)^2 \\
 & = (-1 \cdot 6a^{-5}b^{12})^{-2}(3ab^5)^2 \\
 & = (-1)^{-2}6^{-2}a^{10}b^{-24}3^2a^2b^{10} \\
 & = \frac{1}{(-1)^2} \cdot \frac{3^2}{6^2} \cdot a^{10+2}b^{-24+10} \\
 & = \frac{9}{36}a^{12}b^{-14} \\
 & = \frac{a^{12}}{4b^{14}}
 \end{aligned}$$

$$28. \quad \frac{(x^w)^2}{(x^{4w})^{-2}} = \frac{x^{2w}}{x^{-8w}} = x^{2w-(-8w)} = x^{10w}$$

$$29. \quad 630,000,000 = 6.3 \times 10^8$$

$$30. \quad 0.01200 = 1.2 \times 10^{-2}$$

$$31. \quad 5.0 \times 10^{-6} = 0.000005$$

$$\begin{aligned}
 32. \quad & \frac{(0.00012)(144,000)}{0.0003} = \frac{(1.2 \times 10^{-4})(1.44 \times 10^5)}{3 \times 10^{-4}} \\
 & = \frac{1.728 \times 10^1}{3 \times 10^{-4}} \\
 & = \frac{1.728}{3} \cdot \frac{10^1}{10^{-4}} \\
 & = 0.576 \times 10^5 \\
 & = (5.76 \times 10^{-1}) \times 10^5 \\
 & = 5.76 \times 10^4
 \end{aligned}$$

$$\begin{aligned}
 33. \quad & \frac{(0.0024)(0.00012)}{0.00032} = \frac{(2.4 \times 10^{-3})(1.2 \times 10^{-4})}{3.2 \times 10^{-4}} \\
 & = \frac{(2.4)(1.2)}{3.2} \cdot \frac{(10^{-3})(10^{-4})}{10^{-4}} \\
 & = 0.9 \times 10^{-3} \\
 & = (9 \times 10^{-1}) \times 10^{-3} \\
 & = 9 \times 10^{-4}
 \end{aligned}$$

$$34. \quad 22,600,000,000 = 2.26 \times 10^{10}$$