How far can an athlete run in 10 seconds?

So you can solve real-world problems about . . .
- dinosaurs, p. 67
- giant pumpkins, p. 74
- fitness, p. 81
- aviation, p. 89
- mountain climbing, p. 94
- computers, p. 100
- baseball, p. 106
**MATH In the Real World**

**Track Race** The world’s fastest athletes can run 100 meters in under 10 seconds. In this chapter, you will use equations to solve problems like finding the average rate at which an athlete runs a race.

**What do you think?** Suppose an athlete runs at an average rate of 10.5 meters per second for 10 seconds. Use the formula \( \text{distance} = \text{rate} \times \text{time} \) to find the distance the athlete runs.
Chapter Prerequisite Skills

PREREQUISITE SKILLS QUIZ

Preparing for Success To prepare for success in this chapter, test your knowledge of these concepts and skills. You may want to look at the pages referred to in blue for additional review.

1. Vocabulary Describe the difference between a numerical expression and a variable expression.

Perform the indicated operation. (pp. 774–776)

2. $3.8 + 7.1$  
3. $8.23 - 4.97$  
4. $5.5 \times 9.4$  
5. $6.93 \div 2.1$

Write a variable expression to represent the phrase. (p. 5)

6. 7 more than a number
7. The quotient of a number and 4

Perform the indicated operation. (pp. 29, 34, 42)

8. $-19 + 12$  
9. $8 - (-20)$  
10. $6(-7)$  
11. $-75 \div (-5)$

NOTETAKING STRATEGIES

Using Definition Maps When you study a new concept, you can use a definition map to define the concept, describe the concept’s attributes, and give specific examples. A definition map for power is shown below.

What is it? A power is a product of repeated factors: $2^3 = 2 \cdot 2 \cdot 2$.

What are its attributes? A power consists of a base and an exponent.

The base is the number that is used as a factor. The base for $2^3$ is 2.

The exponent is how many times the base repeats. The exponent for $2^3$ is 3.

What are examples? $2^3$, $(0.5)^6$, $n^4$.

A definition map will be helpful in Lesson 2.3.
Properties and Operations

**Before**
You found sums and products of numbers.

**Now**
You’ll use properties of addition and multiplication.

**Why?**
So you can compare the lengths of two fish, as in Ex. 48.

In English, *commute* means to change locations, and *associate* means to group together. These words have similar meanings in mathematics. *Commutative* properties let you change the positions of numbers in a sum or product. *Associative* properties let you group numbers in a sum or product together.

<table>
<thead>
<tr>
<th>Commutative and Associative Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commutative Property of Addition</strong></td>
</tr>
<tr>
<td>Words: In a sum, you can add the numbers in any order.</td>
</tr>
<tr>
<td>Numbers: &amp; #215; = &amp; #215; + &amp; #215;</td>
</tr>
<tr>
<td>Algebra: &amp; #2227; &amp; #2227; = &amp; #2227; + &amp; #2227;</td>
</tr>
<tr>
<td><strong>Associative Property of Addition</strong></td>
</tr>
<tr>
<td>Words: Changing the grouping of the numbers in a sum does not change the sum.</td>
</tr>
<tr>
<td>Numbers: (9 + 6) + 2 = 9 + (6 + 2)</td>
</tr>
<tr>
<td>Algebra: (a + b) + c = a + (b + c)</td>
</tr>
</tbody>
</table>

**Example 1**

**Using Properties of Addition**

**Music** You buy a portable CD player for $48, rechargeable batteries with charger for $25, and a CD case for $12. Find the total cost.

**Solution**

The total cost is the sum of the three prices. Use properties of addition to group together prices that are easy to add mentally.

\[
48 + 25 + 12 = (48 + 25) + 12
\]

Use order of operations.

\[
= (25 + 48) + 12
\]

Commutative property of addition

\[
= 25 + (48 + 12)
\]

Associative property of addition

\[
= 25 + 60
\]

Add 48 and 12.

\[
= 85
\]

Add 25 and 60.

**Answer** The total cost is $85.
Example 2  Using Properties of Multiplication

Evaluate $4xy$ when $x = -7$ and $y = 25$.

\[
4xy = 4(-7)(25) \quad \text{Substitute } -7 \text{ for } x \text{ and } 25 \text{ for } y.
\]

\[
= [4(-7)](25) \quad \text{Use order of operations.}
\]

\[
= [-7(4)](25) \quad \text{Commutative property of multiplication}
\]

\[
= -7[(4)(25)] \quad \text{Associative property of multiplication}
\]

\[
= -7(100) \quad \text{Multiply 4 and 25.}
\]

\[
= -700 \quad \text{Multiply } -7 \text{ and } 100.
\]

**Checkpoint**

In Exercises 1–3, evaluate the expression. Justify each of your steps.

1. $(17 + 36) + 13$
2. $8(-3)(5)$
3. $3.4 + 9.7 + 7.6$

4. Evaluate $5x^2y$ when $x = -6$ and $y = 20$.

Example 3  Using Properties to Simplify Variable Expressions

Simplify the expression.

a. $x + 3 + 6 = (x + 3) + 6$  \quad \text{Use order of operations.}

\[
= x + (3 + 6) \quad \text{Associative property of addition}
\]

\[
= x + 9 \quad \text{Add 3 and 6.}
\]

b. $4(8y) = (4 \cdot 8)y$  \quad \text{Associative property of multiplication}

\[
= 32y \quad \text{Multiply 4 and 8.}
\]

**Checkpoint**

Simplify the expression.

5. $m + 5 + 9$
6. $6(3k)$
7. $4 + x + (-1)$
8. $(2r)(-5)$

**Identity Properties** When 0 is added to any number, or when any number is multiplied by 1, the result is identical to the original number. These properties of 0 and 1 are called identity properties, and the numbers 0 and 1 are called identities.

<table>
<thead>
<tr>
<th>Identity Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Identity Property of Addition</strong></td>
</tr>
<tr>
<td><strong>Words</strong></td>
</tr>
<tr>
<td><strong>Numbers</strong></td>
</tr>
<tr>
<td><strong>Algebra</strong></td>
</tr>
</tbody>
</table>

| **Identity Property of Multiplication** |
| **Words** | The product of a number and the multiplicative identity, 1, is the number. |
| **Numbers** | $4 \cdot 1 = 4$ |
| **Algebra** | $a \cdot 1 = a$ |
Example 4  Identifying Properties

<table>
<thead>
<tr>
<th>Statement</th>
<th>Property Illustrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ((-5)(1) = -5)</td>
<td>Identity property of multiplication</td>
</tr>
<tr>
<td>b. (2 + (-9) = -9 + 2)</td>
<td>Commutative property of addition</td>
</tr>
<tr>
<td>c. (y^2 + 0 = y^2)</td>
<td>Identity property of addition</td>
</tr>
<tr>
<td>d. (2(pq) = (2p)q)</td>
<td>Associative property of multiplication</td>
</tr>
</tbody>
</table>

Unit Analysis  You can use unit analysis to find a conversion factor that converts a given measurement to different units. A conversion factor, such as \(\frac{1 \text{ foot}}{12 \text{ inches}}\), is equal to 1:

\[
\frac{1 \text{ foot}}{12 \text{ inches}} = \frac{12 \text{ inches}}{12 \text{ inches}} = 1
\]

So, the identity property of multiplication tells you that multiplying a measurement by a conversion factor does not change the measurement.

Example 5  Multiplying by a Conversion Factor

Roller Coasters  The Steel Dragon 2000 is the world’s longest roller coaster. Its length is 2711 yards. How long is the roller coaster in feet?

Solution

1. Find a conversion factor that converts yards to feet. The statement 1 yard = 3 feet gives you two conversion factors.

   \[
   \text{Factor 1: } \frac{1 \text{ yard}}{3 \text{ feet}} \quad \text{Factor 2: } \frac{3 \text{ feet}}{1 \text{ yard}}
   \]

   Unit analysis shows that a conversion factor that converts yards to feet has feet in the numerator and yards in the denominator:

   \[
   \text{yards} \times \frac{\text{feet}}{\text{yards}} = \text{feet}
   \]

   So, factor 2 is the desired conversion factor.

2. Multiply the roller coaster’s length by factor 2 from Step 1.

   \[
   2711 \text{ yards} = 2711 \text{ yards} \times \frac{3 \text{ feet}}{1 \text{ yard}}
   \]

   \[
   = 8133 \text{ feet}
   \]

   Use the conversion factor. Divide out common unit. Multiply.

   Answer  The roller coaster is 8133 feet long.

✔ Checkpoint

9. Identify the property illustrated by the statement \(z^4 \cdot 1 = z^4\).
10. Use a conversion factor to convert 400 centimeters to meters.
Guided Practice

Vocabulary Check
1. Which property allows you to write $4 + (3 + 9) = (4 + 3) + 9$?
2. Explain how the commutative and associative properties of multiplication can help you evaluate the product $5 \cdot 17 \cdot 2$ mentally.

Skill Check

Mental Math Evaluate the expression. Justify each of your steps.
3. $(26 + 18) + 34$  
4. $-4(9)(-5)$  
5. $(3.45)(6.26)(0)$

Evaluate the expression when $x = 5$ and $y = -2$.
6. $33xy$  
7. $x \cdot 11 \cdot y^2$  
8. $x^2 + y^3 + 15$

Simplify the expression.
9. $x + 6 + 11$  
10. $9(-5a)$  
11. $-2 + y + 8$

Identify the property that the statement illustrates.
12. $n + q = q + n$  
13. $-4ab = -4ba$  
14. $(3 \cdot 8) \cdot 2 = 3 \cdot (8 \cdot 2)$

15. Error Analysis Describe and correct the error in converting 80 ounces to pounds.

Practice and Problem Solving

Homework Help

Mental Math Evaluate the expression. Justify each of your steps.
16. $32 + 16 + 8$  
17. $15(-9)(2)$  
18. $7 \cdot 1 + 0$  
19. $45 + 29 + 55$

Evaluate the expression when $a = 9$ and $b = -4$.
20. $5ab$  
21. $b(25a^2)$  
22. $11 + 4b + a$  
23. $3a + b^2 + 13$

Simplify the expression.
24. $x + 17 + 12$  
25. $3 + j + (-9)$  
26. $-8(6c)$  
27. $(5y)(26)$

Identify the property that the statement illustrates.
28. $mn + 0 = mn$  
29. $19 \cdot 5^3 = 5^3 \cdot 19$
30. $(2x + 3y) + z = 2x + (3y + z)$  
31. $(-7u)(1) = -7u$

Use a conversion factor to perform the indicated conversion.
32. 4 miles to feet  
33. 7.5 kilograms to grams
34. 360 seconds to minutes  
35. 432 square inches to square feet

66 Chapter 2 Solving Equations
36. **Nutrition** The calories in a breakfast sandwich come from three sources: 144 Calories are from carbohydrates, 108 Calories are from fat, and 56 Calories are from protein. Use properties of addition to find the total number of calories in the sandwich.

37. **Summer Job** During the summer, you work 4 hours each day as a cashier and earn $7 each hour. Use properties of multiplication to find how much money you earn during a 5 day work week.

38. **Dinosaurs** Scientists believe that the heaviest dinosaur was *Argentinosaurus*, which weighed about 110 tons. Use a conversion factor to find the weight of *Argentinosaurus* in pounds.

39. **Tennis** The area of a regulation tennis court is 2808 square feet. Use a conversion factor to find the area of a tennis court in square yards.

40. **Writing** Are putting on your socks and putting on your shoes commutative activities? Explain.

**Mental Math** Evaluate the expression. Justify each of your steps.

41. \( 1.25 + 1.38 + 0.75 \)  
42. \( 44 + 19 + 16 + 31 \)  
43. \( 4(20)(25)(-5) \)

Evaluate the expression when \( x = -5, \ y = 3, \) and \( z = 2. \)

44. \( x^2 \cdot y \cdot z^2 \)  
45. \( 15\cdot xy \cdot z \)  
46. \( 2x + 9y + 5z \)

47. **Surveying** A surveyor measures the depth of a river at three different points and obtains depths of 4.7 meters, 8.5 meters, and 6.3 meters.
   a. Use properties of addition to find the sum of the surveyor’s measurements.
   b. **Analyze** What is the mean depth?

48. **Extended Problem Solving** One type of fish eaten by swordfish is the mackerel. A swordfish can grow to a length of about 5 yards, while the length of an adult mackerel is about 18 inches.
   a. Copy and complete:
   
   \[ 5 \text{ yards} = 5 \text{ yards} \cdot \frac{? \text{ feet}}{1 \text{ yard}} \cdot \frac{? \text{ inches}}{1 \text{ foot}} \]

   b. **Evaluate** Use properties of multiplication to evaluate the product in part (a). What is the length of a swordfish in inches?

   c. **Compare** A swordfish is how many times as long as a mackerel?

49. **Logical Reasoning** Copy and complete the table. Use the results in each row to decide whether subtraction and division are commutative or associative operations. Explain your reasoning.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Result</th>
<th>Expression</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 - 3</td>
<td>?</td>
<td>3 - 8</td>
<td>?</td>
</tr>
<tr>
<td>10 ÷ 5</td>
<td>?</td>
<td>5 ÷ 10</td>
<td>?</td>
</tr>
<tr>
<td>(15 - 9) - 4</td>
<td>?</td>
<td>15 - (9 - 4)</td>
<td>?</td>
</tr>
<tr>
<td>(48 ÷ 6) ÷ 2</td>
<td>?</td>
<td>48 ÷ (6 ÷ 2)</td>
<td>?</td>
</tr>
</tbody>
</table>

50. **Critical Thinking** When you divide any number \( a \) by 1, what is the result? Write an algebraic statement that expresses this property.
51. **Fundraising** To raise money for a charitable organization, 10 members each sell $x$ boxes of greeting cards for $12$ a box. Each box costs the organization $4$.

   a. The profit on each box of cards sold is the difference of the selling price and the organization's cost. What is the profit on each box?

   b. Use properties of multiplication to write a simplified variable expression for the organization's total profit from card sales.

   c. **Apply** What is the total profit if each member sells 25 boxes of cards?

52. **Challenge** When mathematician Carl Friedrich Gauss was a child, his teacher is said to have asked Gauss and his classmates to add up the integers 1 through 100. Gauss found the answer almost immediately. He first wrote the sum forwards and backwards, as shown.

   \[
   \begin{array}{cccccccccccc}
   1 & + & 2 & + & 3 & + & \cdots & + & 98 & + & 99 & + & 100 \\
   100 & + & 99 & + & 98 & + & \cdots & + & 3 & + & 2 & + & 1 \\
   \end{array}
   \]

   a. You can pair each number in the top sum with the number below it in the bottom sum. What is the sum of the numbers in each pair?

   b. How many pairs of numbers are there?

   c. Use your answers from parts (a) and (b) to complete this statement:

   If $S$ is the sum of the integers 1 through 100, then $2S = \underline{?}$.

   d. **Interpret** What is the sum of the integers 1 through 100? Explain.

---

**Mixed Review**

Evaluate the expression. (*Lessons 1.2, 1.3*)

53. $3^4$  
54. $2^5$  
55. $10^3$

56. $2 + 3 \cdot 8$  
57. $7 + 6^2 \div 9$  
58. $19 + 5 \cdot 11 - 4$

59. **Groceries** At a grocery store, you buy 3 boxes of spaghetti for $1.19 each and 4 jars of spaghetti sauce for $2.39 each. What is the total cost of your items? (*Lesson 1.3*)

---

Plot the point in a coordinate plane. Describe the location of the point. (*Lesson 1.8*)

60. $P(4, 3)$  
61. $Q(2, -2)$  
62. $R(-5, 0)$  
63. $S(-1, -4)$

64. **Multiple Choice** Which conversion factor would you use to find the number of pints in 3 quarts?

   A. $\frac{1}{2}$ quarts  
   B. $\frac{2}{1}$ pints  
   C. $\frac{2}{1}$ quarts  
   D. $\frac{1}{2}$ pints

65. **Multiple Choice** Identify the property illustrated by this statement:

   $2 \cdot (9 \cdot 17) = (2 \cdot 9) \cdot 17$

   F. Identity property of multiplication  
   G. Commutative property of multiplication  
   H. Associative property of multiplication  
   I. Associative property of addition
Perimeter and Area

Review these topics in preparation for solving problems that involve perimeter and area in Lessons 2.2–2.7. You will learn more about area in Chapter 10.

**Perimeter**

Below are formulas for the perimeter of several basic geometric figures.

- **Triangle**
  - \( P = a + b + c \)

- **Square**
  - \( P = 4s \)

- **Rectangle**
  - \( P = 2l + 2w \)

**Example** Find the perimeter of the square.

\[
P = 4s \\
= 4(7) \\
= 28 \text{ cm}
\]

**Area of a Square or Rectangle**

Below are formulas for the area of a square and a rectangle.

- **Square**
  - \( \text{Area} = (\text{Side length})^2 \)
  - \( A = s^2 \)

- **Rectangle**
  - \( \text{Area} = \text{Length} \times \text{Width} \)
  - \( A = lw \)

**Example** Find the area of the rectangle.

\[
A = lw \\
= 9(5) \\
= 45 \text{ in.}^2
\]
Area of a Triangle

You can find a triangle’s area if you know its base and its height.

\[ \text{Area} = \frac{1}{2} \times \text{Base} \times \text{Height} \]

\[ A = \frac{1}{2}bh \]

**Example** Find the area of the triangle.

\[ A = \frac{1}{2}bh \]

Write formula for area.

\[ = \frac{1}{2}(14)(8) \]

Substitute 14 for \( b \) and 8 for \( h \).

\[ = 56 \text{ m}^2 \]

Multiply.

**Checkpoint**

Find the perimeter of the triangle, square, or rectangle.

1. \[ \text{Perimeter} = 2 \times (7 + 11) = 36 \text{ ft} \]

2. \[ \text{Perimeter} = 4 \times 8.5 = 34 \text{ m} \]

3. \[ \text{Perimeter} = 2 \times (27 + 24) = 90 \text{ in.} \]

Find the area of the triangle, square, or rectangle.

4. \[ \text{Area} = 18 \times 18 = 324 \text{ in.}^2 \]

5. \[ \text{Area} = 20 \times 30 = 600 \text{ cm}^2 \]

6. \[ \text{Area} = \frac{1}{2} \times 6 \times 10 = 30 \text{ m}^2 \]

7. **Basketball** A regulation high school basketball court is a rectangle 84 feet long and 50 feet wide. Find the perimeter and the area of the basketball court.

8. **Critical Thinking** The sides of square B are twice as long as the sides of square A, as shown.

   a. Find the perimeter of each square.

   b. Find the area of each square.

   c. **Compare** How are the perimeters of the squares related? How are the areas of the squares related?
The Distributive Property

You used properties to add and multiply. You’ll use the distributive property. So you can find the snowfall in Utah Olympic Park, as in Ex. 37.

Camping You and a friend are going on a camping trip. You each buy a backpack that costs $90 and a sleeping bag that costs $60. What is the total cost of the camping equipment?

Example 1 Evaluating Numerical Expressions

You can use two methods to find the total cost of the camping equipment described above.

Method 1 Find the cost of one backpack and one sleeping bag. Then multiply the result by 2, the number of each item bought.

   \[
   \text{Total cost} = 2(90 + 60) \\
   = 2(150) \\
   = 300
   \]

Method 2 Find the cost of two backpacks and the cost of two sleeping bags. Then add the costs.

   \[
   \text{Total cost} = 2(90) + 2(60) \\
   = 180 + 120 \\
   = 300
   \]

Answer The total cost of the camping equipment is $300.

In Example 1, the expressions \(2(90 + 60)\) and \(2(90) + 2(60)\) are called equivalent numerical expressions because they have the same value. The statement \(2(90 + 60) = 2(90) + 2(60)\) illustrates the distributive property for evaluating the product of a number and a sum or difference.

The Distributive Property

<table>
<thead>
<tr>
<th>Algebra</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a(b + c) = ab + ac)</td>
<td>(4(6 + 3) = 4(6) + 4(3))</td>
</tr>
<tr>
<td>((b + c)a = ba + ca)</td>
<td>((6 + 3)4 = 6(4) + 3(4))</td>
</tr>
<tr>
<td>(a(b - c) = ab - ac)</td>
<td>(5(7 - 2) = 5(7) - 5(2))</td>
</tr>
<tr>
<td>((b - c)a = ba - ca)</td>
<td>((7 - 2)5 = 7(5) - 2(5))</td>
</tr>
</tbody>
</table>
**Example 2**  
**Using the Distributive Property**

**Geodes** After touring a cave, you visit the gift shop and buy 3 geodes. Each geode costs $5.95. Use the distributive property and mental math to find the total cost of the geodes.

**Solution**

Total cost = 3(5.95)  
= 3(6 – 0.05)  
= 3(6) – 3(0.05)  
= 18 – 0.15  
= 17.85

Write expression for total cost.  
Rewrite 5.95 as 6 – 0.05.  
Distributive property  
Multiply using mental math.  
Subtract using mental math.

**Answer** The total cost of the geodes is $17.85.

**Checkpoint**

Use the distributive property to evaluate the expression.

1. 3(8 + 5)  
2. (2 + 9)2  
3. 6(11 – 4)  
4. (3 – 14)(–5)

Evaluate the expression using the distributive property and mental math.

5. 4(105)  
6. 3(97)  
7. 5(2.9)  
8. 8(7.02)

Two variable expressions that have the same value for all values of the variable(s) are called **equivalent variable expressions**. You can use the distributive property to write equivalent variable expressions.

**Example 3**  
**Writing Equivalent Variable Expressions**

Use the distributive property to write an equivalent variable expression.

a. 3(x + 7) = 3(x) + 3(7)  
   = 3x + 21  
   Distributive property  
   Multiply.

b. (n + 4)(–2) = n(–2) + 4(–2)  
   = –2n + (–8)  
   = –2n – 8  
   Distributive property  
   Multiply.  
   Definition of subtraction

c. –5(2y – 3) = –5(2y) – (–5)(3)  
   = –10y – (–15)  
   = –10y + 15  
   Distributive property  
   Multiply.  
   Definition of subtraction

**Checkpoint**

Use the distributive property to write an equivalent variable expression.

9. 8(x + 2)  
10. (7 – 6)(–4)  
11. 9(3m + 5)  
12. –2(6y – 4)
Example 4  Finding Areas of Geometric Figures

Find the area of the rectangle or triangle.

a.\[
\begin{align*}
\text{2x + 5} \\
7
\end{align*}
\]

b.\[
\begin{align*}
8 \quad - \quad 3y \\
12
\end{align*}
\]

Solution

a. Use the formula for the area of a rectangle.
\[
A = lw \\
= (2x + 5)(7) \\
= 2x(7) + 5(7) \\
= 14x + 35
\]
Answer: The area is \((14x + 35)\) square units.

b. Use the formula for the area of a triangle.
\[
A = \frac{1}{2}bh \\
= \frac{1}{2}(12)(8 \quad - \quad 3y) \\
= 6(8 \quad - \quad 3y) \\
= 6(8) \quad - \quad 6(3y) \\
= 48 \quad - \quad 18y
\]
Answer: The area is \((48 \quad - \quad 18y)\) square units.

Guided Practice

Vocabulary Check
1. What property is illustrated by the statement \(3(4 - 9) = 3(4) - 3(9)\)?
2. Are \(2(x + 1)\) and \(2x + 1\) equivalent variable expressions? Explain.

Skill Check

Evaluate the expression using the distributive property and mental math.

3. \(3(96)\)  
4. \(6(103)\)  
5. \(2(8.95)\)  
6. \(4(7.09)\)

Use the distributive property to write an equivalent variable expression.

7. \(2(x - 6)\)  
8. \((y + 11)(-3)\)  
9. \(5(4k + 9)\)  
10. \(-4(2n - 7)\)

11. **Game Room** You are building a game room adjacent to your living room. The widths of the two rooms must be the same. There are no restrictions on the game room's length \(l\).

   a. Write an expression for the total area of both rooms by multiplying their common width by their combined length.

   b. Write a second expression for the total area by finding the area of each room separately and then adding the two areas.

   c. Show that the expressions from parts (a) and (b) are equivalent.
Use the distributive property to evaluate the expression.

12. \((5 + 3)\)  
13. \((9 - 3)\)  
14. \((4 - 10)7\)  
15. \((7.2 + 1.9)2\)  
16. \(-10(18 + 8)\)  
17. \((6 + 21)(-3)\)  
18. \((12 - 7)(-4)\)  
19. \(6(-2.3 + 3.8)\)

Evaluate the expression using the distributive property and mental math.

20. \(4(98)\)  
21. \(7(109)\)  
22. \((211)(-3)\)  
23. \(-5(396)\)  
24. \(8(3.1)\)  
25. \(2(1.99)\)  
26. \(-6(10.95)\)  
27. \((4.02)(-9)\)

Use the distributive property to write an equivalent variable expression.

28. \(4(x - 2)\)  
29. \(3(y + 9)\)  
30. \(-2(3 - r)\)  
31. \((s + 20)(-7)\)  
32. \(6(2p + 1)\)  
33. \(-5(5q - 4)\)  
34. \(9(11 - 6m)\)  
35. \((-2n - 3)(-8)\)

36. Basketball There are 29 teams in the National Basketball Association (NBA). Each team can have a maximum of 12 healthy players plus 3 players on injured reserve. Use the distributive property to find the maximum number of players who can be in the NBA.

37. Snowfall Utah Olympic Park, site of the 2002 Olympic Winter Games, gets an average of 295 inches of snow each year. Use estimation to predict the total snowfall in Utah Olympic Park over a 5 year period. Justify your answer using the distributive property and mental math.

Geometry Find the area of the rectangle or triangle.

38. \(3x - 2 \times 4\)  
39. \(18 \times 5a + 7\)  
40. \(6 - 2y \times 13\)

Use the distributive property to evaluate the expression.

41. \(5(7 + 2 + 4)\)  
42. \(-3(9 - 1 + 6)\)  
43. \((21 - 11 - 3)/4\)

44. Giant Pumpkins A giant pumpkin can be difficult to weigh directly on a scale. To estimate the weight, you can first measure the distances \(a\), \(b\), and \(c\) (in inches) as shown below. The weight \(W\) (in pounds) can then be approximated using the formula \(W = 1.9(a + b + c)\).

\[a\]  
\[b\]  
\[c\]

a. Use the distributive property to write the given formula without parentheses.

b. For a certain pumpkin, \(a = 132\) inches, \(b = 91\) inches, and \(c = 85\) inches. Approximate the weight of the pumpkin to the nearest pound.
45. **Extended Problem Solving** For a cylindrical corn silo with the dimensions shown, the weight $W$ (in pounds) of the corn silage inside is typically given by $W = 4400(40 - d)$, where $d$ is the distance (in feet) from the top of the corn to the top of the silo.

   a. Use the distributive property to write the given formula without parentheses.

   b. **Calculate** Suppose $d = 15$ feet. What is the weight of the corn in the silo?

   c. **Interpret and Apply** How many days will the amount of corn from part (b) last if it is used to feed a herd of 100 cows and each cow eats 10 pounds of corn a day?

Use the distributive property to write an equivalent variable expression.

46. $x(x + 9)$  
47. $m(5 - m)$  
48. $(2u - 7)u$  
49. $-3(y + 8)$

50. **Challenge** Llamas are often raised as pets or to carry supplies in mountainous areas. Suppose you are building a rectangular pen for a herd of llamas. You use 500 feet of fencing for the pen. Let $x$ represent the pen's length (in feet).

   a. **Writing** Write an expression for the width of the pen. Explain the steps you used to find the expression.

   b. Use the distributive property to write an expression without parentheses for the area of the pen.

   c. Find the width and the area of the pen if the length is 160 feet.

---

**Mixed Review**

Find the sum or difference. (Lessons 1.5, 1.6)

51. $20 + (-9)$  
52. $-34 + 16$  
53. $-81 - 58$  
54. $65 - (-27)$

55. **Temperature** Find the mean of the following temperatures: $-15^\circ F$, $-7^\circ F$, $8^\circ F$, $3^\circ F$, $-9^\circ F$. (Lesson 1.7)

Identify the property that the statement illustrates. (Lesson 2.1)

56. $(x + 5y) + 2 = x + (5y + 2)$  
57. $3m + 2n = 2n + 3m$

58. $r^2s = sr^2$  
59. $c^7 \cdot 1 = c^7$

60. **Multiple Choice** Which expression is equivalent to $-3(-7 + 2x)$?

   A. $21 - 6x$  
   B. $21 + 2x$  
   C. $21 + 6x$  
   D. $-21 - 6x$

61. **Multiple Choice** What is the area (in square units) of the rectangle shown?

   F. $4y + 13$  
   G. $8y + 26$  
   H. $20y + 8$  
   I. $20y + 40$

62. **Short Response** You and a friend go to the movies. You each buy a ticket for $9.00 and a popcorn-and-drink combo for $5.25. Describe two methods you can use to find the total amount of money you and your friend spend. What is the total amount spent?
Rates and Unit Analysis

Writing Unit Rates

A rate is a comparison, using division, of quantities measured in different units. Rates are often expressed as fractions. A unit rate has a denominator of 1 unit when the rate is written as a fraction. When a unit rate is expressed as a verbal phrase, it often contains the word per, which means “for every.”

**Example**  Unit rate as a phrase  Unit rate as a fraction

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 45 miles per hour</td>
<td>$\frac{45 \text{ mi}}{1 \text{ h}}$</td>
</tr>
<tr>
<td>b. $3$ per square foot</td>
<td>$\frac{3}{1 \text{ ft}^2}$</td>
</tr>
</tbody>
</table>

Rates and Unit Analysis

You can include unit analysis in a calculation so that you know the units in the answer.

**Example**  At a grocery store, the price of bananas is $1.19 per pound. What is the cost of 3 pounds of bananas?

Total cost = Price per pound × Number of pounds

$= \frac{1.19}{1 \text{ lb}} \times 3 \text{ lb}$  Substitute. Divide out common unit.

$= 3.57$  Multiply.

**Answer**  The cost of the bananas is $3.57.

Rates and Variable Expressions

You can use a rate to write a variable expression.

**Example**  You fill a pool with water at a rate of 20 gallons per minute. Write an expression for the volume of water in the pool after $t$ minutes.

Volume = Gallons per minute × Number of minutes

$= 20t$

**Answer**  The volume of water in the pool is $20t$ gallons.
Using a Formula

Many rate problems involve units of distance and time. The formula below relates distance traveled to the rate of travel and the travel time.

\[ d = \text{Rate} \times \text{Time} \]

In problems about distance, rate, and time, the word *speed* means the same thing as *rate*.

**Example**  An ocean liner travels at a constant speed of 36 miles per hour. How far does the ocean liner travel in 4.5 hours?

\[ d = \text{rt} \]

Write formula for distance traveled.

\[ = \frac{36 \text{ mi}}{1 \text{ h}} \times 4.5 \text{ h} \]

Substitute. Divide out common unit.

\[ = 162 \text{ mi} \]

Multiply.

**Answer** The ocean liner travels 162 miles.

---

**Checkpoint**

Write the rate as a fraction.

1. 17 meters per second
2. $360 per ounce
3. 1.5 inches per hour
4. 0.75 pound per square foot

5. Cows A milk cow grazing in a field eats about 30 pounds of grass per day. How many pounds does the cow eat in 5 days?

6. Snails A snail travels at a speed of about 23 inches per hour. How far can a snail travel in 4 hours?

7. Carpentry You want to carpet a rectangular bedroom that is 5 yards long and 4 yards wide. You buy the carpet for $11.50 per square yard. What is the total cost of the carpet?

8. Space Probe In 1989, the space probe *Magellan* was launched. It traveled toward the planet Venus at a speed of about 25,000 miles per hour. How far did *Magellan* travel in one day?

9. Nutrition A certain brand of salsa contains 15 Calories per ounce. Write an expression for the number of calories in *x* ounces.

10. Skiing You ski down a hill at a speed of 70 feet per second. Write an expression for the distance you travel in *t* seconds.
Simplifying Variable Expressions

**Fitness** You work out each day after school by jogging around a track and swimming laps in a pool. In Example 4, you’ll see how to write and simplify a variable expression that describes the number of calories you burn.

The parts of an expression that are added together are called **terms**. In the expression below, the terms are \( 5x, 4x, \) and 7. The **coefficient** of a term with a variable is the number part of the term.

\[
5x + 4x + 7
\]

Terms

Coefficients are 5 and 4.

A **constant term**, such as 7, has a number but no variable. **Like terms** are terms that have identical variable parts. In the expression above, \( 5x \) and \( 4x \) are like terms. Two or more constant terms are also considered like terms.

**Example 1** **Identifying Parts of an Expression**

Identify the terms, like terms, coefficients, and constant terms of the expression \( y + 8 - 5y - 3 \).

**Solution**

1. Write the expression as a sum: \( y + 8 + (-5y) + (-3) \).
2. Identify the parts of the expression. Note that because \( y = 1y \), the coefficient of \( y \) is 1.

   **Terms:** \( y, 8, -5y, -3 \)  
   **Like terms:** \( y \) and \( -5y \); 8 and \(-3\)

   **Coefficients:** 1, \(-5\)  
   **Constant terms:** 8, \(-3\)
**Simplifying Expressions** You can use the distributive property to write an expression such as $7x + 4x$ as a single term:

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

The like terms $7x$ and $4x$ have been combined, and the expression $7x + 4x$ has been simplified. A variable expression is simplified if it contains no grouping symbols and all like terms are combined.

**Example 2**

**Simplifying an Expression**

$$4n - 7 - n + 9 = 4n + (-7) + (-n) + 9$$

$$= 4n + (-n) + (-7) + 9$$

$$= 4n + (-1)n + (-7) + 9$$

$$= [4 + (-1)]n + (-7) + 9$$

$$= 3n + 2$$

**Checkpoint**

For the given expression, identify the terms, like terms, coefficients, and constant terms. Then simplify the expression.

1. $3x + 2 + 5x$
2. $-7b + 3 + b - 10$
3. $5 + 8w - 6 - w$

A quick way to combine like terms containing variables is to add their coefficients mentally. In Example 2, for instance, $4n + (-n) = 3n$ because $4 + (-1) = 3$. This shortcut will be used from now on in this book.

**Example 3**

**Simplifying Expressions with Parentheses**

a. $2(x - 4) + 9x + 1 = 2x - 8 + 9x + 1$

$$= 2x + 9x - 8 + 1$$

$$= 11x - 7$$

b. $3k - 8(k + 2) = 3k - 8k - 16$

$$= -5k - 16$$

c. $4a - (4a - 3) = 4a - 1(4a - 3)$

$$= 4a - 4a + 3$$

$$= 0 + 3$$

$$= 3$$

**Checkpoint**

Simplify the expression.

4. $4(x + 1) + 2x + 5$
5. $10y - 3(6 - y)$
6. $8c + 2 - (c + 2)$

**Lesson 2.3** Simplifying Variable Expressions
During your workout described on page 78, you spend a total of 45 minutes jogging and swimming. You burn 14 Calories per minute when jogging and 8 Calories per minute when swimming.

a. Let \( j \) be the time you jog (in minutes). Write an expression in terms of \( j \) for the total calories you burn during your workout.

b. Find the total number of calories burned if you jog for 20 minutes.

Solution

a. Write a verbal model for the total number of calories burned.

\[
\text{Calories per minute jogging} \times \text{Jogging time} + \text{Calories per minute swimming} \times \text{Swimming time}
\]

Use the verbal model to write a variable expression, then simplify it. Note that because your entire workout lasts 45 minutes and your jogging time is \( j \), your swimming time must be \( 45 - j \).

\[
14j + 8(45 - j) = 14j + 360 - 8j \quad \text{Distributive property}
\]

\[
= 14j - 8j + 360 \quad \text{Group like terms.}
\]

\[
= 6j + 360 \quad \text{Combine like terms.}
\]

b. Evaluate the expression in part (a) when \( j = 20 \).

\[
6j + 360 = 6(20) + 360 = 480 \text{ Calories}
\]

Guided Practice

1. What are terms that have a number but no variable called?

2. What is the coefficient of \( y \) in the expression \( 8 - 3y + 1 \)?

Skill Check

For the given expression, identify the terms, like terms, coefficients, and constant terms. Then simplify the expression.

3. \( 6x + x + 2 + 4 \)  
4. \( -4k - 12 + 3k \)  
5. \( 5n + 1 - n - 8 \)

Simplify the expression.

6. \( 5x + 2 + 3(x - 1) \)  
7. \( -7(2r + 3) + 11r \)  
8. \( p + 6 - 6(p - 2) \)

9. Error Analysis Describe and correct the error in simplifying \( 5a - (3a - 7) \).

\[
5a - (3a - 7) = 5a - 3a - 7 
\]

\[
= 2a - 7
\]
For the given expression, identify the terms, like terms, coefficients, and constant terms. Then simplify the expression.

10. $10x + 7 + 3x$
11. $4y + 23 - y - 6$
12. $-19 - 11a + a + 16$
13. $2b - 8 + 4b - 6b$
14. $9 + n - 1 - 7n$
15. $8p - 5p + 5 - p - 2$

Simplify the expression.

16. $4x + 2x$
17. $10a - 3a$
18. $b - 9b$
19. $x + 2x + 3x$
20. $9c^2 - 4c^2 + 2c^2$
21. $3(2y + 5y)$
22. $4(d + 3) + 7d$
23. $5(k - 7) - k + 7$
24. $-2(2m - 1) + 4m$
25. $8n - (n - 3)$
26. $20u - 6(u + 5)$
27. $-w + 4 - (3w - 13)$
28. $p - 5(2 - 3p) + 1$
29. $3(q + 4) + 4q + 1$
30. $-7(r^2 + 2) + 3r^2$

31. **Fitness** Look back at Example 4 on page 80. Let $s$ represent the time (in minutes) that you spend swimming. Write and simplify an expression in terms of $s$ for the total number of calories you burn during your workout.

32. **Trains** A freight train with 80 cars transports coal and iron ore. Each car carries either 100 tons of coal or 90 tons of iron ore.

   a. Let $c$ represent the number of cars carrying coal. Write and simplify an expression in terms of $c$ for the total weight of the freight transported by the train.

   b. Suppose 28 of the train's cars carry coal. What is the total weight of all the freight?

**Geometry** Write and simplify an expression for the perimeter of the triangle or rectangle.

33. \[ \frac{x}{2x + 1} \]
34. \[ \frac{2a}{10 - 3a} \]
35. \[ \frac{2y}{7y - 5} \]

36. **Extended Problem Solving** You are making a rectangular rug. You want the rug to be twice as long as it is wide. Let $w$ represent the width (in feet) of the rug.

   a. Write an expression in terms of $w$ for the perimeter of the rug.

   b. Write an expression in terms of $w$ for the area of the rug.

   c. **Calculate** Copy and complete the table.

<table>
<thead>
<tr>
<th>Width (feet)</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter (feet)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Area (square feet)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

   d. **Writing** Explain how doubling the width of the rug affects the perimeter and the area.
37. **Agriculture** A farmer grows tomatoes and cucumbers in the field shown. The annual cost of growing tomatoes is \$0.27 per square foot. The annual cost of growing cucumbers is \$0.10 per square foot. Let \( x \) represent the width (in feet) of the tomato portion of the field.

a. In terms of \( x \), what is the area of the tomato portion? of the cucumber portion?

b. Write and simplify an expression in terms of \( x \) for the annual cost of growing both crops.

c. Find the annual cost of growing both crops if the width of the tomato portion is 350 feet.

38. **Challenge** You want to stock your aquarium with three types of fish: angelfish, swordtails, and tetras. Each angelfish costs \$5, each swordtail costs \$2, and each tetra costs \$3. You plan to buy 20 fish.

a. Let \( a \) be the number of angelfish and \( s \) be the number of swordtails you buy. In terms of \( a \) and \( s \), how many tetras do you buy?

b. Write and simplify an expression in terms of \( a \) and \( s \) for the total cost of your fish.

c. Of the 20 fish you buy, 4 are angelfish and 10 are swordtails. Use your expression from part (b) to find your total cost.

---

**Mixed Review**

39. **Cubing a Number** When a number \( x \) is cubed, the result is 2744. Use the problem solving strategy **guess, check, and revise** to find the value of \( x \). *(p. 797)*

Write a variable expression to represent the phrase. *(Lesson 1.1)*

40. The product of 8 and a number

41. 3 less than a number

42. A number increased by 10

43. The quotient of a number and 6

Use the distributive property to write an equivalent variable expression. *(Lesson 2.2)*

44. \(4(a + 2)\)

45. \(-2(x + 3)\)

46. \(7(p - 4)\)

47. \((m - 5)(-6)\)

48. \(5(2q + 11)\)

49. \(8(3t - 7)\)

50. \(-4(1 - 5u)\)

51. \((8w + 9)(-3)\)

---

**Standardized Test Practice**

52. **Multiple Choice** Which terms are **not** like terms?

A. \(8y\) and \(-4y\)

B. 2 and 3.14

C. \(x^2\) and \(x^5\)

D. \(x^2\) and \(5x^2\)

53. **Multiple Choice** Which expression is equivalent to \(8t - 6(2t - 1)\)?

F. \(4t + 6\)

G. \(-4t - 6\)

H. \(-4t - 1\)

I. \(-4t + 6\)

54. **Short Response** You have a canteen that holds 32 fluid ounces and weighs 0.25 pound when empty. Water weighs 0.065 pound per fluid ounce. You begin a hike with a full canteen of water. Write and simplify an expression for the weight of the canteen and water after you drink \(x\) fluid ounces. Show and justify each step of your solution.
2.3 Simplifying Expressions

**Goal** Use a graphing calculator to check simplified variable expressions.

**Example**

Simplify the expression $5x - 2(x - 4)$. Use a graphing calculator to check the result.

1. **Simplify the given expression.**
   
   \[5x - 2(x - 4) = 5x - 2x + 8\]  
   \[\text{Distributive property}\]  
   \[= 3x + 8\]  
   \[\text{Combine like terms}.\]

2. **To check the result from Step 1, first enter the original expression and the simplified expression into the calculator.**

   **Keystrokes**
   
   \[Y= 5 \times - 2\]  
   \[(\times - 4)\]  
   \[ENTER\]  
   \[Y= 3 \times + 8\]

3. **Use the calculator’s table feature to evaluate the original and simplified expressions for different values of $x$.**

   Press \[2nd [TblSet]\] and enter the settings shown in the first screen below. Then press \[2nd [Table]\] to display the table shown in the second screen.

   ![Table Setup Screen](image)

   **Compare the values of the original expression in the column for Y1 with the values of the simplified expression in the column for Y2.** The values are the same, so the simplification is correct.

4. **Draw Conclusions**

   **Simplify. Use a graphing calculator to check the result.**

   1. $7(x + 2)\quad$ 2. $2x + 4x + 6x\quad$ 3. $3x - 9 - 8x + 5$
   4. $-6(x - 3) + 5x\quad$ 5. $11x - 3(x + 5)\quad$ 6. $2(3x + 4) - 6x$
   7. **Critical Thinking** Show that $2(x - 1) + x$ and $4x - 2$ are equal when $x = 0$. Are the expressions equivalent? Explain.
Evaluate the expression. Justify each of your steps.

1. \(29 + 18 + 21\)  
2. \(1.3 + 6.8 + 2.7\)  
3. \(4(9)(-25)\)  
4. \(5(-7)(-12)\)

5. **Swimming** In 1998, Susie Maroney set a record for the longest ocean swim without flippers. She swam 122 miles from Mexico to Cuba. Use a conversion factor to find this distance in feet.

Use the distributive property to evaluate the expression.

6. \(-3(8 + 5)\)  
7. \((11 - 4)6\)  
8. \(5(98)\)  
9. \(7(4.03)\)

Use the distributive property to write an equivalent variable expression.

10. \(2(x - 3)\)  
11. \(-5(y + 4)\)  
12. \(4(9p + 7)\)  
13. \((6 - 2m)(-3)\)

14. **Geometry** Find the area of the triangle shown.

15. \(12x + 5 + 3x\)  
16. \(9 + a - 2 - 7a\)  
17. \(-8c + 3 - c + 1\)  
18. \(6n - 4n - 2n\)

Simplify the expression.

19. \(3(x + 7) + 2x\)  
20. \(y - 2(y - 6)\)  
21. \(4(r - 1) + 5r + 3\)  
22. \(8s - 4(2s + 3)\)

---

**Word Scramble**

For each statement in the table, identify the type of property the statement illustrates and write the corresponding letter. Unscramble the letters to solve this riddle:

**What word has six letters, but when you subtract one, twelve remain?**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Associative</th>
<th>Commutative</th>
<th>Identity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8 \cdot 1 = 8)</td>
<td>R</td>
<td>T</td>
<td>E</td>
</tr>
<tr>
<td>(3 \cdot 9 = 9 \cdot 3)</td>
<td>A</td>
<td>D</td>
<td>L</td>
</tr>
<tr>
<td>((2 + 5) + 3 = 2 + (5 + 3))</td>
<td>N</td>
<td>Y</td>
<td>B</td>
</tr>
<tr>
<td>(4x + y = y + 4x)</td>
<td>H</td>
<td>S</td>
<td>U</td>
</tr>
<tr>
<td>(5(7c) = (5 \cdot 7)c)</td>
<td>O</td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>(xy + 0 = xy)</td>
<td>M</td>
<td>I</td>
<td>Z</td>
</tr>
</tbody>
</table>
Variables and Equations

**Vocabulary**
- equation, p. 85
- solution of an equation, p. 85
- solving an equation, p. 86

You evaluated variable expressions.
You’ll solve equations with variables.
So you can find worldwide sales of computers, as in Ex. 33.

**Biology** Lotus flowers like the one shown can be grown from seeds hundreds of years old. In Example 4, you’ll see how an equation can be used to estimate the year when an ancient lotus seed was formed.

An **equation** is a mathematical sentence formed by placing an equal sign, =, between two expressions. A **solution** of an equation with a variable is a number that produces a true statement when it is substituted for the variable.

**Example 1**

**Writing Verbal Sentences as Equations**

<table>
<thead>
<tr>
<th>Verbal Sentence</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The sum of (x) and 6 is 9.</td>
<td>(x + 6 = 9)</td>
</tr>
<tr>
<td>b. The difference of 12 and (y) is 15.</td>
<td>(12 - y = 15)</td>
</tr>
<tr>
<td>c. The product of (-4) and (p) is 32.</td>
<td>(-4p = 32)</td>
</tr>
<tr>
<td>d. The quotient of (n) and 2 is 9.</td>
<td>(\frac{n}{2} = 9)</td>
</tr>
</tbody>
</table>

**Example 2**

**Checking Possible Solutions**

Tell whether 9 or 7 is a solution of \(x - 5 = 2\).

<table>
<thead>
<tr>
<th>a. Substitute 9 for (x).</th>
<th>b. Substitute 7 for (x).</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x - 5 = 2)</td>
<td>(x - 5 = 2)</td>
</tr>
<tr>
<td>(9 - 5 \neq 2)</td>
<td>(7 - 5 \neq 2)</td>
</tr>
<tr>
<td>(4 \neq 2)</td>
<td>(2 = 2)</td>
</tr>
</tbody>
</table>

**Answer** 9 is not a solution. **Answer** 7 is a solution.

**Checkpoint**

In Exercises 1 and 2, write the verbal sentence as an equation.

1. The sum of 3 and \(z\) is \(-10\).  
2. The quotient of \(m\) and 6 is 4.  
3. Tell whether \(-5\) or 5 is a solution of \(-8y = 40\).
Solving Equations  Finding all solutions of an equation is called solving the equation. You can use mental math to solve a simple equation by thinking of the equation as a question.

Example 3  Solving Equations Using Mental Math

<table>
<thead>
<tr>
<th>Equation</th>
<th>Question</th>
<th>Solution</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( x + 3 = 11 )</td>
<td>What number plus 3 equals 11?</td>
<td>8</td>
<td>8 + 3 = 11 ✓</td>
</tr>
<tr>
<td>b. ( 16 - m = 9 )</td>
<td>16 minus what number equals 9?</td>
<td>7</td>
<td>16 - 7 = 9 ✓</td>
</tr>
<tr>
<td>c. ( 20 = 5t )</td>
<td>20 equals 5 times what number?</td>
<td>4</td>
<td>20 = 5(4) ✓</td>
</tr>
<tr>
<td>d. ( \frac{y}{6} = -3 )</td>
<td>What number divided by 6 equals -3?</td>
<td>-18</td>
<td>( \frac{-18}{6} = -3 ) ✓</td>
</tr>
</tbody>
</table>

Checkpoint

Solve the equation using mental math.

4. \( x - 10 = 7 \)  
5. \( 2 + n = -6 \)  
6. \( 3w = -15 \)  
7. \( 4 = \frac{36}{5} \)

Example 4  Writing and Solving an Equation

From 1998 to 2002, biologist Jane Shen-Miller grew several lotus plants from ancient seeds she found in China. The oldest seed was about 500 years old. Estimate the year when this seed was formed.

Solution

First write a verbal model for this situation.

\[
\text{Year seed was formed} + \text{Age of seed when it sprouted} = \text{Year seed sprouted}
\]

Let \( x \) represent the year when the seed was formed. Because you are only trying to estimate \( x \) (rather than determine \( x \) precisely), you can use 2000 for the year when the seed sprouted. This year simplifies mental calculations and lies within the given time period, 1998–2002.

\[
x + 500 = 2000
\]

Substitute for quantities in verbal model.

\[
1500 + 500 = 2000
\]

Use mental math to solve for \( x \).

Answer  Because \( x = 1500 \), the seed was formed around the year 1500.

Checkpoint

8. Go-cart rides cost $5 each at a county fair. During the first day of the fair, the go-cart operator takes in a total of $1000. How many times did people ride the go-carts that day? Write and solve an equation to find the answer.
2.4 Exercises

Guided Practice

Vocabulary Check
1. Copy and complete: A(n) __ of an equation is a number that produces a true statement when it is substituted for the variable.

2. What question would you ask yourself if you want to solve the equation \(-4t = 28\) mentally?

Skill Check

Write the verbal sentence as an equation. Then tell whether 5 is a solution of the equation.

3. The sum of \(x\) and 10 is 15. 4. The difference of 3 and \(x\) is 2.

5. The product of \(-6\) and \(x\) is 54. 6. The quotient of \(-40\) and \(x\) is \(-8\).

Guided Problem Solving

7. Appetizers You are having a party and are serving quesadillas as appetizers. There will be 12 people at the party. Each quesadilla will be cut into 4 wedges, and you expect each person to eat 3 wedges. How many quesadillas do you need to make?

   1) Let \(x\) represent the number of quesadillas you need. Write an expression for the number of wedges in \(x\) quesadillas.

   2) How many quesadilla wedges do you need to feed 12 people?

   3) Use your answers from Steps 1 and 2 to write an equation that you can use to find the number of quesadillas needed.

   4) Solve your equation to find how many quesadillas you need.

Practice and Problem Solving

Write the verbal sentence as an equation.

8. The difference of \(x\) and 8 is \(-4\). 9. The sum of 26 and \(y\) is 43.

10. The quotient of \(p\) and 7 is 16. 11. The product of 14 and \(m\) is 56.

Tell whether the given value of the variable is a solution of the equation.

12. \(x + 9 = 12; x = -3\) 13. \(21 - z = -4; z = 25\)

14. \(91 = 7c; c = 13\) 15. \(\frac{y}{4} = -8; y = 32\)

Match the equation with the corresponding question. Then solve.

16. \(n + 3 = 12\) A. 3 times what number equals 12?

17. \(3n = 12\) B. What number divided by 3 equals 12?

18. \(3 = n + 12\) C. What number plus 3 equals 12?

19. \(\frac{n}{3} = 12\) D. 3 equals what number plus 12?
**Mental Math** Solve the equation using mental math.

20. \( x + 6 = 13 \)  
21. \( x - 8 = 20 \)  
22. \( 0 = t + 79 \)  
23. \( -4 + y = -9 \)

24. \( 11 - p = 19 \)  
25. \( -2 = r - 7 \)  
26. \( 7x = 63 \)  
27. \( -10a = 130 \)

28. \( -54 = -9g \)  
29. \( \frac{x}{5} = 6 \)  
30. \( \frac{48}{u} = -3 \)  
31. \( 1 = \frac{n}{231} \)

**In Exercises 32–34, use an equation to solve the problem.**

32. **Insects** The dragonfly is the fastest flying insect. It can move at a speed of about 50 feet per second. Find the approximate time it takes a dragonfly to travel 400 feet.

33. **Computers** From 2000 to 2001, annual worldwide sales of personal computers declined by about 6 million. In 2001, about 128 million personal computers were sold. Find the approximate number of personal computers sold in 2000.

34. **Snacks** You divide a bag of trail mix into 8 portions for you and your friends to have as snacks on a bike ride. Each portion weighs 3 ounces. Find the total weight of the trail mix originally in the bag.

35. **Geometry** The perimeter of the figure shown is 35 centimeters.

a. Write an equation that you can use to find \( x \).

b. Solve your equation. What is the value of \( x \)?

![Perimeter Diagram](image)

36. **Extended Problem Solving** Scientists often use the Kelvin scale to measure temperature. The temperature \( K \) in kelvins (K) is related to the temperature \( C \) in degrees Celsius (°C) by this formula:

\[ K = C + 273 \]

a. **Writing** Explain in words how to find the Kelvin temperature that is equivalent to a given Celsius temperature.

b. The lowest possible temperature a substance can have is 0 K, which is called absolute zero. What is absolute zero in degrees Celsius?

c. The table shows the melting points of several chemical elements in kelvins. Find each melting point in degrees Celsius.

<table>
<thead>
<tr>
<th>Element</th>
<th>Melting point (K)</th>
<th>Melting point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>63</td>
<td>?</td>
</tr>
<tr>
<td>Chlorine</td>
<td>172</td>
<td>?</td>
</tr>
<tr>
<td>Gallium</td>
<td>303</td>
<td>?</td>
</tr>
<tr>
<td>Radium</td>
<td>973</td>
<td>?</td>
</tr>
</tbody>
</table>

37. **Compare and Contrast** Describe the difference between an equation and an expression. Give an example of each.
38. **Crafts** You make a decorative paper chain with \( n \) links by cutting a 9 inch by 12 inch sheet of construction paper into \( n \) strips.

\[
\begin{array}{ccc}
\text{12 in.} & \text{n strips} & \text{9 in.} \\
\hline
\end{array}
\]

\[
\begin{array}{ccc}
\text{12 in.} & \text{n links} & \text{9 in.} \\
\hline
\end{array}
\]

a. Write an expression in terms of \( n \) for the width of each paper strip.

b. Suppose you want each strip to be 0.75 inch wide. Use the problem solving strategy *guess, check, and revise* to find the number of links your paper chain will have.

39. **Aviation** The Thunderbirds are a United States Air Force team of pilots who fly in air shows around the world. The type of plane they fly, the F-16 Falcon, can climb at a rate of about 800 feet per second.

a. Suppose the Thunderbirds perform a straight-up climb from an altitude of 200 feet to an altitude of 13,000 feet. Let \( x \) represent the time (in seconds) that it takes to complete this maneuver. Use the verbal model below to write an equation you can use to find \( x \).

\[
\begin{array}{ccc}
\text{Beginning altitude} & + & \text{Rate of climb} \cdot \text{Climbing time} = \text{Final altitude} \\
\hline
\end{array}
\]

b. Use the *table* feature on a graphing calculator to evaluate the left side of your equation for different values of \( x \). What is the solution of the equation? How long does it take the Thunderbirds to complete the climb?

40. **Challenge** Solve the equation \( 2x + 3 = 11 \) using mental math. Explain the reasoning you used to find the solution.

### Mixed Review

**Evaluate the expression when \( x = -5 \) and \( y = -3 \).** *(Lessons 1.5, 1.6)*

41. \( x + y \)  
42. \( x - y + 6 \)  
43. \( -x + 2 + 3y \)

**Evaluate the expression using the distributive property and mental math.** *(Lesson 2.2)*

44. \( 8(104) \)  
45. \( 5(197) \)  
46. \( 4(2.8) \)

**Simplify the expression.** *(Lesson 2.3)*

47. \( 5c + 2 + 7c \)  
48. \( 13k - 8k - k \)  
49. \( 6x - 3 + 4x + 1 \)
50. \( 3(y + 7) + 11y \)  
51. \( p - 6 - (4 + p) \)  
52. \( 2n - 7(n - 8) \)

### Standardized Test Practice

**53. Multiple Choice** Two more than a number is 8. Which equation can you solve to find the number?

A. \( 2x = 8 \)  
B. \( x + 2 = 8 \)  
C. \( x + 8 = 2 \)  
D. \( 2 + 8 = x \)

**54. Multiple Choice** What is the solution of the equation \( 12p = 60 \)?

F. \( 3 \)  
G. \( 4 \)  
H. \( 5 \)  
I. \( 6 \)
2.5 Modeling Addition Equations

**Goal**
Model and solve addition equations.

**Materials**
- algebra tiles

You can use algebra tiles to model and solve simple addition equations.

![x-tile and 1-tile images](image)

An x-tile represents the variable \( x \).

A 1-tile represents the number 1.

**Investigate**

**Use algebra tiles to solve \( x + 3 = 5 \).**

1. Model \( x + 3 = 5 \) with algebra tiles.

2. Get the x-tile by itself on one side of the equation by removing three 1-tiles from each side.

3. The x-tile is equal to two 1-tiles. So, the solution of \( x + 3 = 5 \) is 2.

**Draw Conclusions**

1. Which model would you use to represent the equation \( x + 2 = 4 \)?

   A. ![Model A](image)

   B. ![Model B](image)

**Use algebra tiles to model and solve the equation.**

2. \( x + 1 = 4 \)
3. \( x + 2 = 6 \)
4. \( x + 5 = 7 \)
5. \( x + 4 = 10 \)
6. \( 3 + x = 8 \)
7. \( 2 + x = 11 \)
8. \( 3 = x + 7 \)
9. \( 16 = 9 + x \)

10. **Writing** In Step 2, why is it necessary to subtract three 1-tiles from each side of the equation, rather than from just the left side?

11. **Critical Thinking** Describe how you can use algebra tiles to solve the equation \( 2 + x + 4 = 9 \). Then solve.
Solving Equations Using Addition or Subtraction

**Horses** One method for weighing a horse is to put it in a trailer of known weight and weigh the horse and trailer together on a truck scale. As you’ll see in Example 3, the horse’s weight can then be found by using an inverse operation to solve an equation.

**Inverse operations** are two operations that undo each other, such as addition and subtraction. When you perform the same inverse operation on each side of an equation, you obtain an equivalent equation. **Equivalent equations** are equations that have the same solution(s).

**Subtraction Property of Equality**

**Words** Subtracting the same number from each side of an equation produces an equivalent equation.

**Numbers** If \( x + 3 = 5 \), then \( x + 3 - 3 = 5 - 3 \), or \( x = 2 \).

**Algebra** If \( x + a = b \), then \( x + a - a = b - a \), or \( x = b - a \).

**Example 1**

**Solving an Equation Using Subtraction**

**Solve** \( x + 9 = -3 \).

\[
\begin{align*}
x + 9 &= -3 \\
x + 9 - 9 &= -3 - 9 \\
x &= -12
\end{align*}
\]

**Write original equation.**

**Subtract 9 from each side.**

**Simplify.**

**Answer** The solution is \(-12\).

**Check**

\[
\begin{align*}
x + 9 &= -3 \\
-12 + 9 &= -3 \\
-3 &= -3 \checkmark
\end{align*}
\]

**Write original equation.**

**Substitute \(-12\) for \( x \).**

**Solution checks.**
Addition Property Just as you can use the subtraction property of equality to solve an equation involving addition, you can use the addition property of equality to solve an equation involving subtraction.

Addition Property of Equality

Words Adding the same number to each side of an equation produces an equivalent equation.

Numbers If \( x - 3 = 5 \), then \( x - 3 + 3 = 5 + 3 \), or \( x = 8 \).

Algebra If \( x - a = b \), then \( x - a + a = b + a \), or \( x = b + a \).

Example 2 Solving an Equation Using Addition

Solve \( 23 = y - 11 \).

\[
23 = y - 11 \\
23 + 11 = y - 11 + 11 \\
34 = y
\]

Write original equation.
Add 11 to each side.
Simplify.

Answer The solution is 34.

Example 3 Writing and Solving an Equation

You weigh a horse using the method described on page 91. The weight of the trailer alone is 2150 pounds. The combined weight of the horse and trailer is 3375 pounds. What is the weight of the horse?

Solution

Let \( w \) represent the horse’s weight (in pounds). Write a verbal model. Then use the verbal model to write an equation.

\[
\text{Weight of horse} + \text{Weight of trailer} = \text{Combined weight}
\]

\[
w + 2150 = 3375 \\
w + 2150 - 2150 = 3375 - 2150 \\
w = 1225
\]

Substitute.
Subtract 2150 from each side.
Simplify.

Answer The weight of the horse is 1225 pounds.

Checkpoint

Solve the equation. Check your solution.

1. \( x + 8 = 19 \)    2. \( -7 = y + 13 \)    3. \( n - 4 = -11 \)    4. \( 26 = p - 61 \)

5. While holding his cat, Ben steps on a scale. The scale reads 161 pounds. Ben weighs 148 pounds. What is the weight of the cat?
Guided Practice

**Vocabulary Check**

1. Copy and complete: Addition and subtraction are \_\_ operations.

2. Which property of equality would you use to solve \( x - 5 = 7 \)? Explain.

**Skill Check**

Solve the equation. Check your solution.

3. \( x + 4 = 10 \)

4. \( t + 9 = -5 \)

5. \( u - 3 = 6 \)

6. \( y - 7 = -2 \)

7. \( 16 = a + 25 \)

8. \( -70 = b - 30 \)

9. **Error Analysis** Describe and correct the error in solving \( x + 8 = 10 \).

   \[ x + 8 = 10 \]
   \[ x + 8 - 8 = 10 + 8 \]
   \[ x = 18 \]

10. **Population** From 1990 to 2000, the population of Cresco, Iowa, increased by 236. The population in 2000 was 3905. Use an equation to find the population in 1990.

Practice and Problem Solving

Solve the equation. Check your solution.

11. \( x + 7 = 12 \)

12. \( y + 9 = 0 \)

13. \(-2 = z + 6 \)

14. \( a - 5 = 8 \)

15. \( b - 14 = -3 \)

16. \( 37 = c - 29 \)

17. \( 21 + m = 4 \)

18. \( n - 72 = 72 \)

19. \( p - 24 = -53 \)

20. \( q + 8 = 57 \)

21. \( r - 23 = -6 \)

22. \( 28 = g + 28 \)

23. \(-13 + t = 10 \)

24. \( 216 = u - 129 \)

25. \( 177 = 403 + w \)

26. **Rebates** The advertised price of a DVD player is $185 after a $30 mail-in rebate. Using the verbal model below, write and solve an equation to find the price of the DVD player before the rebate is applied.

   \[ \text{Price before rebate} - \text{Rebate amount} = \text{Price after rebate} \]

27. **Biology** When attacked by a giant hornet, Japanese honeybees cluster together to form a ball around the hornet and then generate heat by buzzing. The honeybees can endure temperatures of up to 48°C, which is 3°C greater than the hornet can tolerate. Find the maximum temperature tolerated by a Japanese giant hornet.

28. **Archaeology** The Great Pyramid in Egypt was built around 2560 B.C. Over the years, it has lost 30 feet of height off its top and is now 451 feet tall. Find the original height of the Great Pyramid.
29. **Mountain Climbing** In 1988, Stacy Allison became the first woman from the United States to reach the summit of Mount Everest, which is 29,035 feet high. One year earlier, she and a team of Americans had attempted to climb Mount Everest but were forced to turn back at an altitude of 26,000 feet due to severe storms. How close to the summit did Stacy Allison get on her first attempt?

30. **Astronomy** Cepheid stars appear to pulsate because they expand and contract in size. In its contracted phase, the Cepheid star Zeta Geminorum is 51 million miles across. This is 5 million miles less than the star’s distance across in its expanded phase. Find the distance across Zeta Geminorum in its expanded phase.

31. **Writing** In Example 1 on page 91, the subtraction property of equality is used to solve \( x + 9 = -3 \). Explain how you can also solve this equation using the addition property of equality.

**Solve the equation. Check your solution.**

32. \( a + 5 + 8 = 20 \)
33. \( 3 + c + 6 = -9 \)
34. \( 9 + x - 4 = 2 \)
35. \( n - 6 - 1 = 5 \)
36. \( 0 = r + 7 - 32 \)
37. \( -5 = -17 + y + 8 \)

**Geometry** Find the value of \( x \) for the given triangle or rectangle.

38. Perimeter = 34 in. 39. Perimeter = 59 cm 40. Perimeter = 352 ft

![Triangle and Rectangle Diagrams]

41. **Extended Problem Solving** Doctors measure the cholesterol in your blood to see if you are at risk for heart disease. The formula below gives your total cholesterol level in terms of your LDL (or “bad”) cholesterol, your HDL (or “good”) cholesterol, and your triglycerides.

\[
\text{Total cholesterol} = \text{LDL} + \text{HDL} + \frac{\text{Triglycerides}}{5}
\]

All values are measured in milligrams per deciliter (mg/dL) of blood.

a. When your cholesterol is checked by a doctor, the total cholesterol, HDL cholesterol, and triglycerides are measured directly. The LDL cholesterol is then calculated from these values. Write an equation that you can use to find the LDL level for the patient whose lab results are shown.

![Lab Results Table]

b. **Solve** Find the patient’s LDL level by solving your equation from part (a).

c. **Interpret** For teenagers, LDL levels below 110 mg/dL are considered acceptable. Levels from 110 mg/dL to 129 mg/dL are borderline, and levels of 130 mg/dL or greater are too high. Classify the LDL level of the given patient as acceptable, borderline, or too high.
42. **History** In 1628, the Swedish ship *Vasa* sank in Stockholm Harbor in 105 feet of water. In 1959, salvagers used pontoons and cables to move the *Vasa* to a shallower depth of 50 feet. Underwater repairs were then made to strengthen the ship, and in 1961 the *Vasa* was lifted to the surface.
   
a. Find the change in the *Vasa*’s position with respect to sea level as a result of the salvage work done in 1959.
   
b. Find the number of years the *Vasa* remained underwater.

43. **Critical Thinking** In Example 2 on page 92, you saw that the equation $34 = y$ is equivalent to $23 = y - 11$. Write an equation that has $y + 5$ as its right side and is also equivalent to $23 = y - 11$.

44. **Quilting** You are making a quilt and have $150 to spend on materials. To make the main body of the quilt, you buy 5 yards of solid-color fabric for $4 per yard and 12 yards of printed fabric for $8 per yard. You also buy 2 yards of batting (material used to stuff the quilt) for $11 per yard. How much can you spend on fabric for a decorative border?


---

**Mixed Review**

Write the product using an exponent. *(Lesson 1.2)*

46. $6 \cdot 6 \cdot 6 \cdot 6$  
47. $(0.3)(0.3)$  
48. $x \cdot x \cdot x$  
49. $t \cdot t \cdot t \cdot t \cdot t$

Evaluate the power. *(Lesson 1.2)*

50. $2^6$  
51. $7^4$  
52. $(0.8)^2$  
53. $(2.5)^3$

State the opposite of the number. *(Lesson 1.4)*

54. 8  
55. $-27$  
56. 0  
57. 144

Evaluate the expression when $x = 4$ and $y = -7$. *(Lesson 1.4)*

58. $|x|$  
59. $|y|$  
60. $|y| + |-y|$  
61. $|y| - |-x|$  

62. **Dolphins** A dolphin can swim at a constant speed of 20 miles per hour for long periods of time. How long does it take a dolphin to swim 60 miles? *(Lesson 2.4)*

**Standardized Test Practice**

63. **Multiple Choice** What is the solution of $x + 18 = -13$?
   
   A. $-31$  
   B. $-5$  
   C. 5  
   D. 31

64. **Multiple Choice** What is the solution of $-21 = a - 47$?
   
   F. $-68$  
   G. $-26$  
   H. 26  
   I. 68

65. **Short Response** A company hired 140 employees during a year in which 93 employees retired or left the company for other reasons. At the end of the year, the company had 816 employees. Find the number of employees the company had at the beginning of the year. Show and justify each step of your solution.
2.6 Modeling Multiplication Equations

**Goal**
Model and solve multiplication equations.

**Materials**
- algebra tiles

You can use algebra tiles to model and solve simple multiplication equations. For a description of algebra tiles, see page 90.

**Investigate**

1. **Use algebra tiles to solve** $3x = 12$.
   
   **Model** $3x = 12$ with algebra tiles.
   
   ![Algebra Tiles](image)

2. **There are three $x$-tiles, so divide the $x$-tiles and 1-tiles into three equal groups.**
   
   ![Algebra Tiles](image)

3. **One $x$-tile is equal to four 1-tiles.**
   **So, the solution of** $3x = 12$ **is 4.**
   
   ![Algebra Tiles](image)

**Draw Conclusions**

**Use algebra tiles to model and solve the equation.**

1. $2x = 4$
2. $2x = 10$
3. $3x = 18$
4. $4x = 12$
5. $6x = 6$
6. $5x = 20$
7. $21 = 7x$
8. $21 = 3x$

9. **Writing** For each algebra-tile equation in the example shown above, write a corresponding algebraic equation. Based on your results, describe an algebraic method that you can use to solve $8x = 56$. Then use your method to find the equation's solution.

10. **Critical Thinking** Describe how you can use algebra tiles to solve the equation $2x + 3x = 15$. Then solve.
Solving Equations Using Multiplication or Division

You solved addition and subtraction equations. You’ll solve equations using multiplication or division. So you can find how long it takes whales to migrate, as in Ex. 35.

Astronomy In 1995, the Solar and Heliospheric Observatory (SOHO) was launched into space. SOHO studies the sun, including high-speed gas called solar wind that is ejected from the sun and travels throughout the solar system.

In Example 3, you’ll see how to use a multiplication equation to find how long it takes solar wind to reach Earth. You can use division to solve such an equation, because multiplication and division are inverse operations.

### Division Property of Equality

**Words** Dividing each side of an equation by the same nonzero number produces an equivalent equation.

**Numbers** If $3x = 12$, then $\frac{3x}{3} = \frac{12}{3}$, or $x = 4$.

**Algebra** If $ax = b$ and $a \neq 0$, then $\frac{ax}{a} = \frac{b}{a}$ or $x = \frac{b}{a}$.

### Example 1

**Solving an Equation Using Division**

Solve $-6x = 48$.

- $-6x = 48$ Write original equation.
- $\frac{-6x}{-6} = \frac{48}{-6}$ Divide each side by $-6$.
- $x = -8$ Simplify.

**Answer** The solution is $-8$.

**Check** $-6x = 48$ Write original equation.
- $-6(-8) = 48$ Substitute $-8$ for $x$.
- $48 = 48$ Solution checks.
**Multiplication Property** To solve an equation that involves division, you can use the *multiplication property of equality*.

### Multiplication Property of Equality

**Words** Multiplying each side of an equation by the same nonzero number produces an equivalent equation.

**Numbers** If \( \frac{x}{3} = 12 \), then \( 3 \cdot \frac{x}{3} = 3 \cdot 12 \), or \( x = 36 \).

**Algebra** If \( \frac{x}{a} = b \) and \( a \neq 0 \), then \( a \cdot \frac{x}{a} = a \cdot b \), or \( x = ab \).

---

### Example 2

**Solving an Equation Using Multiplication**

Solve \( 9 = \frac{w}{7} \).

\[
9 = \frac{w}{7} \quad \text{Write original equation.}
\]

\[
7 \cdot 9 = 7 \cdot \frac{w}{7} \quad \text{Multiply each side by 7.}
\]

\[
63 = w \quad \text{Simplify.}
\]

**Answer** The solution is 63.

---

**Checkpoint**

Solve the equation. Check your solution.

1. \( 2x = 18 \)
2. \( -60 = -5a \)
3. \( \frac{y}{2} = 13 \)
4. \( -8 = \frac{b}{8} \)

---

### Example 3

**Writing and Solving an Equation**

On January 4, 2003, the SOHO spacecraft described on page 97 detected solar wind traveling at about 2 million kilometers per hour. The sun is about 150 million kilometers from Earth. About how long did it take the solar wind to reach Earth?

**Solution**

Let \( t \) be the time (in hours) that it took the solar wind to reach Earth.

\[
d = rt
\]

\[
150,000,000 = 2,000,000t \quad \text{Write formula for distance traveled.}
\]

\[
\frac{150,000,000}{2,000,000} = \frac{2,000,000t}{2,000,000} \quad \text{Substitute values.}
\]

\[
75 = t \quad \text{Divide each side by 2,000,000.}
\]

**Simplify.**

**Answer** It took the solar wind about 75 hours to reach Earth.
Guided Practice

Vocabulary Check
1. Copy and complete: Multiplication and _?_ are inverse operations.

2. Which property of equality would you use to solve \( \frac{x}{5} = 12 \)? Explain.

Skill Check
Solve the equation. Check your solution.
3. \( 5c = -15 \)  
4. \( 54 = 9x \)  
5. \( \frac{u}{4} = 6 \)  
6. \( \frac{y}{-10} = 7 \)

Guided Problem Solving
7. Printers You buy the inkjet printer shown in the advertisement. You use it to print a 40 page document in black and white and a 20 page document in color. How long does it take to print both documents?

1. Write and solve an equation to find the time it takes to print the black and white document.

2. Write and solve an equation to find the time it takes to print the color document.

3. Find the time it takes to print both documents.

Practice and Problem Solving

Solve the equation. Check your solution.
8. \( 3x = 27 \)  
9. \( 4y = 52 \)  
10. \( -65 = 13u \)  
11. \( 84 = -21v \)

12. \( \frac{x}{7} = 5 \)  
13. \( \frac{y}{-3} = 8 \)  
14. \( 16 = \frac{p}{6} \)  
15. \( -7 = \frac{q}{11} \)

16. \( -23a = 0 \)  
17. \( -95 = -5b \)  
18. \( -r = 38 \)  
19. \( 301 = 43s \)

20. \( \frac{c}{-2} = -91 \)  
21. \( 17 = \frac{d}{17} \)  
22. \( 9 = \frac{m}{-36} \)  
23. \( \frac{n}{62} = -54 \)

24. Football During the 2002 regular season of the National Football League, running back Michael Bennett played in 16 games and averaged 81 rushing yards per game. Find his total rushing yards by using the verbal model below to write and solve an equation.

\[
\text{Average rushing yards per game} = \frac{\text{Total rushing yards}}{\text{Number of games played}}
\]
25. **Drilling** One type of thermal ice drill can drill through ice at a rate of 15 feet per minute by using heat to melt the ice. Find the time it takes the drill to melt through a sheet of ice 75 feet thick.

26. **Reforestation** In 1998, fire destroyed 100 acres of the Oakwood National Wildlife Refuge in Arkansas. The U.S. Fish and Wildlife Service reforested this area by planting tree seedlings at a density of 300 seedlings per acre. Find the total number of seedlings planted.

27. **Computers** Your favorite rock band distributes one of its songs for free on its website. The size of the song file is 3584 kilobytes (KB). The table shows the maximum speed at which files can be downloaded using each type of Internet service offered in your town.

<table>
<thead>
<tr>
<th>Type of service</th>
<th>Dial-up</th>
<th>DSL</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Download speed (KB/sec)</td>
<td>7</td>
<td>96</td>
<td>188</td>
</tr>
</tbody>
</table>

To the nearest second, how long does it take to download the song file using dial-up service? using DSL service? using cable service?

**Solve the equation. Check your solution.**

28. \(7x - 3x = 24\)  
29. \(-110 = 12y + 10y\)  
30. \(-4(9g) = 252\)

31. \(150 = 6(5h)\)  
32. \(-3 = \frac{x}{6 + 11}\)

33. \(\frac{w}{8} = 9 - (-4)\)

34. **Geometry** The figure shown is composed of a triangle and a rectangle.

   a. Write and simplify an expression in terms of \(x\) for the area of the figure.

   b. What is the value of \(x\) if the area of the figure is 154 square feet?

35. **Extended Problem Solving** Each year gray whales migrate about 5000 miles from the Baja Peninsula of Mexico to their feeding grounds near Alaska. The whales travel about 100 miles per day.

   a. Write an expression for the distance the whales travel in \(x\) days.

   b. Copy and complete the table using your expression from part (a).

<table>
<thead>
<tr>
<th>Travel time (days)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance traveled (miles)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

c. Make a scatter plot of the data in the table. Show travel time on the \(x\)-axis and distance traveled on the \(y\)-axis. Describe the pattern formed by the points in the scatter plot.

d. **Apply** Extend the pattern you described in part (c) by plotting points for \(x = 30, 35,\) and so on until you plot a point whose \(y\)-coordinate is 5000. How many days does it take the whales to migrate from the Baja Peninsula to Alaska?

e. **Reasonableness** Justify your solution to part (d) by solving the equation \(100x = 5000\).
36. **Watches** A wristwatch has a built-in digital camera with a rectangular viewfinder. An image shown by the viewfinder consists of 6240 tiny rectangular dots called pixels arranged in rows and columns. The viewfinder has 80 rows of pixels. How many columns does it have?

37. **Writing** Describe a real-life problem that can be solved using the equation $50x = 400$. Then solve the problem.

38. **Lightning** On July 1, 2001, a Pennsylvania weather station detected an average of 80 lightning strikes per minute over a 24 hour period. Find the total number of lightning strikes detected during that time.

39. **Challenge** The problem below is a variation of one that appears in the ancient Chinese text *Nine Chapters on the Mathematical Art*. (In the problem, a *tou* is a Chinese unit of measure.)

A goat, a horse, and a cow mistakenly enter a farmer’s wheat field and eat some stalks of wheat. The horse eats twice as many stalks as the goat, and the cow eats twice as many stalks as the horse. The farmer demands 5 *tou* of wheat from the owners of the animals to replace what was eaten. How much wheat should be replaced by the goat’s owner? by the horse’s owner? by the cow’s owner?

- **a.** Let $x$ be the amount of wheat (in *tou*) that should be replaced by the goat’s owner. What is an expression in terms of $x$ for the amount that should be replaced by the horse’s owner? by the cow’s owner?

- **b.** Write and solve an equation to find $x$. To the nearest tenth of a *tou*, how much wheat should be replaced by each animal’s owner?

### Mixed Review

**Perform the Indicated Operation.** *(pp. 774–776)*

- 40. $2.9 + 8.4$
- 41. $7.63 + 5.18$
- 42. $13.8 - 9.3$
- 43. $3.239 - 1.74$
- 44. $4.6 \times 2.3$
- 45. $6.51 \times 9.22$
- 46. $53.6 \div 6.7$
- 47. $8.16 \div 3.4$

**Perform the Indicated Operation.** *(Lessons 1.5–1.7)*

- 48. $-19 + 40$
- 49. $-26 + (-7)$
- 50. $3 - 18$
- 51. $-12 - (-10)$
- 52. $5(-14)$
- 53. $-23(-8)$
- 54. $-90 \div 15$
- 55. $-36 \div (-4)$

56. **Plants** From 1994 to 2001, the number of plant species classified as endangered increased by 177. There were 593 endangered plant species in 2001. Find the number of endangered plant species in 1994.

*(Lesson 2.5)*

### Standardized Test Practice

57. **Multiple Choice** What is the solution of $\frac{x}{-2} = -8$?

- A. $-16$
- B. $-4$
- C. $4$
- D. $16$

58. **Multiple Choice** Starting with a full tank of gas, your family’s car is driven 420 miles and then refueled. It takes 12 gallons of gas to fill the car’s tank. How many miles per gallon did the car get?

- F. $25$ mi/gal
- G. $30$ mi/gal
- H. $35$ mi/gal
- I. $40$ mi/gal
Decimal Operations and Equations with Decimals

**Before**
You solved equations involving integers.

**Now**
You’ll solve equations involving decimals.

**Why?**
So you can find the speed of an airplane, as in Ex. 47.

**Hibernation** When a chipmunk hibernates, its heart rate decreases, its body temperature drops, and the chipmunk loses weight as its stored body fat is converted to energy. In Example 5, you’ll see how to use an equation with decimals to describe a chipmunk’s weight loss during hibernation.

You already know how to perform operations with positive decimals. However, just as there are negative integers, such as \(-2\), there are also negative decimals, such as \(-2.5\). The number line below shows several positive and negative decimals.

\[\begin{align*}
-3 & \quad -2 & \quad -1 & \quad 0 & \quad 1 & \quad 2 & \quad 3 \\
-2.5 & \quad -1.3 & \quad 0.5 & \quad 1.75
\end{align*}\]

The rules for performing operations with decimals are the same as those you learned for integers in Chapter 1.

**Example 1**  **Adding and Subtracting Decimals**

**a.** Find the sum \(-2.9 + (-6.5)\).

Use the rule for adding numbers with the same sign.

\[-2.9 + (-6.5) = -9.4\]  
Add \(|-2.9|\) and \(|-6.5|\).

Both decimals are negative, so the sum is negative.

**b.** Find the difference \(-25.38 - (-42.734)\).

First rewrite the difference as a sum: \(-25.38 + 42.734\). Then use the rule for adding numbers with different signs.

\[-25.38 + 42.734 = 17.354\]  
Subtract \(|-25.38|\) from \(|42.734|\).  
\(42.734 \geq |-25.38|\), so the sum has the same sign as 42.734.
**Checkpoint**

Find the sum or difference.

1. $-1.3 + (-4.2)$  
2. $10.57 + (-6.89)$  
3. $9.817 - (-1.49)$

**Example 2**  
*Multiplying and Dividing Decimals*

Perform the indicated operation.

a. $-0.7(18.4)$  
b. $-4.5(-9.25)$

c. $-29.07 \div (-1.9)$  
d. $16.83 \div (-3.3)$

**Solution**

a. $-0.7(18.4) = -12.88$  
Different signs: Product is negative.

b. $-4.5(-9.25) = 41.625$  
Same sign: Product is positive.

c. $-29.07 \div (-1.9) = 15.3$  
Same sign: Quotient is positive.

d. $16.83 \div (-3.3) = -5.1$  
Different signs: Quotient is negative.

**Checkpoint**

Find the product or quotient.

4. $3.1(-6.8)$  
5. $-11.41 \div (-0.7)$  
6. $-15.841 \div 2.17$

7. **Critical Thinking**  
Explain how you can use estimation to check that your answer to Exercise 4 is reasonable.

**Solving Equations**  
You can use what you know about decimal operations to solve equations involving decimals.

**Example 3**  
*Solving Addition and Subtraction Equations*

Solve the equation.

a. $x + 4.7 = 3.5$  
b. $y - 6.91 = -2.26$

**Solution**

a. $x + 4.7 = 3.5$  
Write original equation.

$x + 4.7 - 4.7 = 3.5 - 4.7$  
Subtract 4.7 from each side.

$x = -1.2$  
Simplify.

b. $y - 6.91 = -2.26$  
Write original equation.

$y - 6.91 + 6.91 = -2.26 + 6.91$  
Add 6.91 to each side.

$y = 4.65$  
Simplify.

**Checkpoint**

Solve the equation. Check your solution.

8. $x + 3.8 = 5.2$  
9. $a + 10.4 = -1.17$  
10. $6.29 + c = 4.01$

11. $y - 7.8 = 22.3$  
12. $r - 0.88 = -0.56$  
13. $-9.34 = t - 2.75$
Example 4  Solving Multiplication and Division Equations

Solve the equation.

a. \(-0.6m = -5.1\)  
   b. \(\frac{n}{8} = 1.75\)

Solution

a. \(-0.6m = -5.1\)  
   Write original equation.
   
   \[
   \frac{-0.6m}{-0.6} = \frac{-5.1}{-0.6}
   \]
   Divide each side by \(-0.6\).
   
   \(m = 8.5\)  
   Simplify.

b. \(\frac{n}{8} = 1.75\)  
   Write original equation.
   
   \[
   -8 \left(\frac{n}{8}\right) = -8(1.75)
   \]
   Multiply each side by \(-8\).
   
   \(n = -14\)  
   Simplify.

Checkpoint

Solve the equation. Check your solution.

14. \(7x = 40.6\)   15. \(-1.8u = 6.3\)   16. \(\frac{y}{11.5} = 0.4\)   17. \(-9.1 = \frac{v}{-5.9}\)

Example 5  Writing and Solving an Equation

When a chipmunk hibernates, its weight decreases by about 0.31 pound. After hibernation, a chipmunk weighs about 0.35 pound. Find the weight of a chipmunk before hibernation.

Solution

Let \(w\) represent a chipmunk’s weight (in pounds) before hibernation. Write a verbal model. Then use the verbal model to write an equation.

\[
\text{Weight before hibernation} - \text{Weight loss} = \text{Weight after hibernation}
\]

\[
w - 0.31 = 0.35
\]

Substitute.

\[
w - 0.31 + 0.31 = 0.35 + 0.31
\]

Add 0.31 to each side.

\[
w = 0.66
\]

Simplify.

Answer  A chipmunk weighs about 0.66 pound before hibernation.

Checkpoint

18. You use an automated teller machine (ATM) to deposit a check for $122.94 into your savings account. Your receipt from the ATM shows a balance of $286.59 after the deposit. Find the balance of your savings account before the deposit.
Guided Practice

Vocabulary Check
1. Copy and complete: The sum of a positive decimal and a negative decimal has the same sign as the decimal with the greater ___.
2. Describe how you would solve the equation \(-7.9x = 86.9\).

Skill Check

Perform the indicated operation.
3. \(-6.2 + 4.5\)  
4. \(1.9 - (-9.1)\)  
5. \(-0.4(-8.3)\)  
6. \(7.35 + (-2.1)\)

Solve the equation. Check your solution.
7. \(x - 2.2 = 3.2\)  
8. \(y + 0.6 = -1\)  
9. \(\frac{n}{-7.1} = 5.8\)  
10. \(-5.2a = -1.3\)

Guided Problem Solving

11. Earth Science The table shows the year-to-year changes in the mean January water level of Lake Superior during the period 1997–2001. Positive changes represent increases in the water level, while negative changes represent decreases. In 2001, the water level was 182.98 meters. What was the water level in 1997?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Change (meters)</td>
<td>-0.19</td>
<td>-0.28</td>
<td>0.04</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

1) Find the overall change in the water level from 1997 to 2001 by adding the changes in the table.
2) Write an equation that you can use to find the water level in 1997.
3) Solve your equation. What was Lake Superior's water level in 1997?

Practice and Problem Solving

Perform the indicated operation.
12. \(7.8 + (-9.3)\)  
13. \(-1.25 + 14.4\)  
14. \(-2.583 + (-5.399)\)
15. \(6.1 - 18.7\)  
16. \(-3.72 - 4.58\)  
17. \(-0.62 - (-0.741)\)
18. \(-4.8(0.1)\)  
19. \(-11.7(-6.82)\)  
20. \(2.03(-1.66)\)
21. \(34.41 ÷ (-5.5)\)  
22. \(-0.63 ÷ 0.7\)  
23. \(-7.532 ÷ (-2.69)\)

Solve the equation. Check your solution.
24. \(x + 8.5 = 13.7\)  
25. \(a + 4.8 = 2.29\)  
26. \(-3.36 = b + 5.12\)
27. \(y - 1.3 = -7.4\)  
28. \(g - 6.27 = 10.63\)  
29. \(-0.504 + h = -0.18\)
30. \(8w = 75.2\)  
31. \(-0.96j = -0.72\)  
32. \(3.498 = -0.53k\)
33. \(\frac{z}{6.9} = -3\)  
34. \(\frac{r}{0.4} = 0.8\)  
35. \(-9.1 = \frac{s}{-7.12}\)
36. Use the table feature on a graphing calculator to evaluate \(3.7x\) for different values of \(x\). Set TblStart to 0 and \(\Delta \text{Tbl}\) to 0.1. Scroll through the table to find the solution of \(3.7x = 4.81\).

37. Telescopes The W.M. Keck Observatory, located on top of the dormant volcano Mauna Kea in Hawaii, has two telescopes. Each telescope has a mirror composed of 36 identical sections that are fitted together. The total area of the mirror is about 75.8 square meters. Find the area of each section of the mirror to the nearest tenth of a square meter.

38. Baseball A baseball player’s batting average is defined by the verbal model below. During the 2001 Major League Baseball season, Ichiro Suzuki of the Seattle Mariners batted 692 times and had a batting average of .350. How many hits did Suzuki have?

\[
\text{Batting average} = \frac{\text{Number of hits}}{\text{Number of times at bat}}
\]

**Simplify the expression.**

39. \(2.6x - 7.1x\)

40. \(-3.5(4a + 1.9)\)

41. \(0.8(3 - 11n) + 1.4n\)

42. Perimeter = 10 m

43. Area = 75.52 ft\(^2\)

44. Area = 15.75 cm\(^2\)

45. **Extended Problem Solving** The table shows the difference between the amount of money the U.S. government received and the amount it spent for the years 1995–2000. Positive amounts, called surpluses, mean that the government received more than it spent. Negative amounts, called deficits, mean that it received less than it spent.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Surplus or deficit (billions of dollars)</td>
<td>−164.0</td>
<td>−107.5</td>
<td>−22.0</td>
<td>69.2</td>
<td>124.6</td>
<td>236.4</td>
</tr>
</tbody>
</table>

**a. Writing** Without performing any calculations, tell whether the U.S. government received more money or less money than it spent over the entire period 1995–2000. Explain how you got your answer.

**b.** Check your answer from part (a) by calculating the overall surplus or deficit for 1995–2000.

**c.** To the nearest tenth of a billion dollars, what was the mean annual surplus or deficit for 1995–2000?

**d. Compare** Find the median annual surplus or deficit for 1995–2000. Compare the median with the mean.

46. **Challenge** Solve the equations \(0.1x = 1, 0.01x = 1, 0.001x = 1,\) and \(0.0001x = 1\). What happens to the solutions as the coefficients of \(x\) get closer to 0?
47. **Aviation** The Mach number for an airplane is the speed of the airplane divided by the speed of sound. The speed of sound depends on altitude. The table shows the typical Mach numbers of several airplanes and the speed of sound at each airplane’s cruising altitude.

<table>
<thead>
<tr>
<th>Airplane</th>
<th>Mach number at cruising altitude</th>
<th>Speed of sound at cruising altitude (mi/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cessna Skyhawk</td>
<td>0.19</td>
<td>740</td>
</tr>
<tr>
<td>Boeing 747</td>
<td>0.86</td>
<td>663</td>
</tr>
<tr>
<td>Concorde</td>
<td>2.04</td>
<td>660</td>
</tr>
</tbody>
</table>

a. Find each airplane’s speed at its cruising altitude by solving an equation. Round your answers to the nearest mile per hour.

b. To the nearest tenth of an hour, how long does it take each airplane to fly 550 miles?

---

**Mixed Review**

For the given expression, identify the terms, like terms, coefficients, and constant terms. Then simplify the expression. *(Lesson 2.3)*

48. $5x + 11 + 8x$
49. $-3p + 2 + p - 4$
50. $7w - w + 9 - 6w$
51. $8 + 2y - 1 - 9y + 3$

**Solve the equation. Check your solution.** *(Lessons 2.5, 2.6)*

52. $x + 12 = 5$
53. $y - 9 = -4$
54. $32c = 192$
55. $\frac{d}{19} = -8$

---

**Standardized Test Practice**

56. **Extended Response** When you watch waves pass an anchored boat or other stationary point, the elapsed time between waves is called the period. In deep water, the period $T$ (in seconds) and the wave speed $s$ (in miles per hour) are related by the formula $s = 3.49T$.

a. Suppose a storm near Antarctica generates a series of waves with a period of 11 seconds. Find the speed of the waves.

b. Waves from Antarctic storms can reach the coast of Alaska, 8000 miles away. How many hours does it take the waves from part (a) to reach the Alaskan coast? How many days does it take?

---

**Brain Game**

**Runoff**

**How long is a marathon?**

To find the answer, first solve equation 1. Then substitute the solution of equation 1 for $a$ in equation 2, and solve equation 2. Finally, substitute the solution of equation 2 for $b$ in equation 3, and solve equation 3. The solution of equation 3 is a marathon’s length in miles.
Chapter Review

Vocabulary Review

additive identity, p. 64  equivalent variable  like terms, p. 78  solving an equation, p. 86
multiplicative identity, p. 64  expressions, p. 72  equation, p. 85  inverse operations, p. 91
equivalent numerical  term, p. 78  solution of an equation,  equivalent equations, p. 91
expressions, p. 71

coefficient, p. 78  constant term, p. 78

1. What number is the additive identity? What number is the multiplicative identity?
2. Describe how you would solve an equation of the form \( ax = b \) where \( a \neq 0 \).
3. Copy and complete: The expressions \( 2(8 + 3) \) and \( 2(8) + 2(3) \) are ___.
4. In the expression \( 5 - 9n \), what is the coefficient of \( n \)? What is the constant term?

2.1 Properties and Operations

Goal

Use properties of addition and multiplication.

Example Evaluate the expression.

\[ a. \quad 57 + 28 + 13 = (57 + 28) + 13 \quad \text{Use order of operations.} \]
\[ = (28 + 57) + 13 \quad \text{Commutative property of addition} \]
\[ = 28 + (57 + 13) \quad \text{Associative property of addition} \]
\[ = 28 + 70 \quad \text{Add 57 and 13.} \]
\[ = 98 \quad \text{Add 28 and 70.} \]

\[ b. \quad -5(19)(20) = [-5(19)](20) \quad \text{Use order of operations.} \]
\[ = [19(-5)](20) \quad \text{Commutative property of multiplication} \]
\[ = 19[-5(20)] \quad \text{Associative property of multiplication} \]
\[ = 19(-100) \quad \text{Multiply -5 and 20.} \]
\[ = -1900 \quad \text{Multiply 19 and -100.} \]

Evaluate the expression. Justify each of your steps.

5. \( 16 + 18 + 14 \)
6. \( 38 + 23 + (-8) \)
7. \( 4.7 + 2.5 + 2.3 \)
8. \( 4(11)(25) \)
9. \( 5(-3)(12) \)
10. \( 6(13)(0.5) \)
2.2 The Distributive Property

**Goal**

Use the distributive property.

**Example**

Use the distributive property to evaluate $5(204)$.

\[
5(204) = 5(200 + 4) \quad \text{Rewrite 204 as 200 + 4.}
\]
\[
= 5(200) + 5(4) \quad \text{Distributive property}
\]
\[
= 1000 + 20 \quad \text{Multiply.}
\]
\[
= 1020 \quad \text{Add.}
\]

**Example**

Write an expression equivalent to $4(3x - 2)$.

\[
4(3x - 2) = 4(3x) - 4(2) \quad \text{Distributive property}
\]
\[
= 12x - 8 \quad \text{Multiply.}
\]

Use the distributive property to evaluate the expression.

11. $3(106)$
12. $6(99)$
13. $8(5.2)$
14. $(7.95)4$

Write an equivalent variable expression.

15. $-2(x + 4)$
16. $5(y - 8)$
17. $4(7a + 2)$
18. $(6 - 11c)(-3)$

2.3 Simplifying Variable Expressions

**Goal**

Simplify variable expressions.

**Example**

Identify the terms, like terms, coefficients, and constant terms of the expression $7n - 5 - 3n + 2$.

Terms: $7n, -5, -3n, 2$  
Like terms: $7n$ and $-3n$; $-5$ and 2

Coefficients: $7, -3$  
Constant terms: $-5, 2$

**Example**

Simplify the expression $3p + 5 - 8(p + 2)$.

\[
3p + 5 - 8(p + 2) = 3p + 5 - 8p - 16 \quad \text{Distributive property}
\]
\[
= 3p - 8p + 5 - 16 \quad \text{Group like terms.}
\]
\[
= -5p - 11 \quad \text{Combine like terms.}
\]

Identify the terms, like terms, coefficients, and constant terms.

19. $4t + 13t + 2$
20. $x + 5 - 3x - 1$
21. $12 - 7k + 9 - k$

Simplify the expression.

22. $5x - 9 - x + 2$
23. $3(u + 1) + 4u + 1$
24. $8a - 2(7a - 3)$
2.4 Variables and Equations

**Goal**
Use mental math to solve equations.

**Example** Solve the equation using mental math.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Question</th>
<th>Solution</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. (x + 7 = 11)</td>
<td>What number plus 7 equals 11?</td>
<td>4</td>
<td>(4 + 7 = 11) ✓</td>
</tr>
<tr>
<td>b. (y - 9 = 5)</td>
<td>What number minus 9 equals 5?</td>
<td>14</td>
<td>(14 - 9 = 5) ✓</td>
</tr>
<tr>
<td>c. (3n = 21)</td>
<td>3 times what number equals 21?</td>
<td>7</td>
<td>(3(7) = 21) ✓</td>
</tr>
<tr>
<td>d. (-6 = \frac{30}{w})</td>
<td>(-6) equals (30) divided by what number?</td>
<td>(-5)</td>
<td>(-6 = \frac{30}{-5}) ✓</td>
</tr>
</tbody>
</table>

**Goal**
Solve the equation using mental math.

25. \(x + 10 = 23\)  
26. \(7 - y = -1\)  
27. \(36 = -4a\)  
28. \(\frac{b}{5} = 8\)

29. **Trip** Your family drives 150 miles to an amusement park at an average speed of 50 miles per hour. How long does the trip take?

2.5 Solving Equations Using Addition or Subtraction

**Goal**
Use addition or subtraction to solve equations.

**Example** Solve \(x + 19 = 6\).

\[
x + 19 = 6 \\
x + 19 - 19 = 6 - 19 \\
x = -13
\]

Write original equation.  
Subtract 19 from each side.  
Simplify.

**Example** Solve \(m - 42 = -15\).

\[
m - 42 = -15 \\
m - 42 + 42 = -15 + 42 \\
m = 27
\]

Write original equation.  
Add 42 to each side.  
Simplify.

**Goal**
Solve the equation. Check your solution.

30. \(x + 8 = 21\)  
31. \(-9 = t + 16\)  
32. \(p - 7 = -8\)  
33. \(29 = r - 64\)

34. **Salary** An engineer receives a promotion that includes a raise of \(\$4500\) in her annual salary. Her new salary is \(\$50,750\). What was the engineer’s salary before the promotion?
2.6 Solving Equations Using Multiplication or Division

**Goal**
Use multiplication or division to solve equations.

**Example**
Solve \( \frac{r}{13} = -5 \).

\[
\frac{r}{13} = -5 \quad \text{Write original equation.}
\]

\[-13 \left( \frac{r}{13} \right) = -13(-5) \quad \text{Multiply each side by } -13.
\]

\[r = 65 \quad \text{Simplify.}
\]

✔ **Solve the equation. Check your solution.**

35. \(-5x = 45\)  36. \(-5 + 4 = -3y\)  37. \(\frac{a}{8} = 4\)  38. \(9 = \frac{c}{-9}\)

39. **Craft Fair** You divide a stack of fliers for a craft fair into 6 smaller stacks for volunteers to distribute. Each smaller stack contains 15 fliers. What is the total number of fliers distributed?

2.7 Decimal Operations and Equations with Decimals

**Goal**
Use positive and negative decimals.

**Example**
Perform the indicated operation.

\(a\). \(9.74 + (-3.31) = 6.43\)  
Add using rule for different signs.

\(b\). \(-4.2 - 7.9 = -4.2 + (-7.9)\)  
Rewrite as a sum.

\[= -12.1\]  
Add using rule for same signs.

\(c\). \(-2.6(8.4) = -21.84\)  
Different signs: Product is negative.

\(d\). \(-17.67 \div (-3.1) = 5.7\)  
Same sign: Quotient is positive.

**Example**
Solve \(-1.9k = 0.76\).

\[-1.9k = 0.76 \quad \text{Write original equation.}
\]

\[
\frac{-1.9k}{-1.9} = \frac{0.76}{-1.9} \quad \text{Divide each side by } -1.9.
\]

\[k = -0.4 \quad \text{Simplify.}
\]

✔ **Perform the indicated operation.**

40. \(-6.6 + 1.4\)  41. \(2.8 - (-4.7)\)  42. \(-9.4(-5.31)\)  43. \(7 \div (-2.5)\)

**Solve the equation. Check your solution.**

44. \(x + 6 = 1.8\)  45. \(2.4h = -8.4\)  46. \(\frac{n}{5} = -7.3\)  47. \(u - 4.6 = 3.7\)
Evaluate the expression. Justify each of your steps.

1. \(48 + 25 + 22\)  
2. \(15(-7)(4)\)  
3. \(5.9 + 10.4 + 2.1\)  
4. \(36 \cdot 1 + 0\)

Identify the property that the statement illustrates.

5. \(-8(5) = 5(-8)\)  
6. \(4 + 0 = 4\)  
7. \(x^2 + y = y + x^2\)  
8. \(7(xy^2) = (7x)y^2\)

9. Waves The highest ocean wave ever reliably measured was sighted by the U.S.S. Ramapo during a typhoon in 1933. The wave was about 37 yards high. Use a conversion factor to find this height in feet.

Use the distributive property to evaluate the expression.

10. \(7(8 - 3)\)  
11. \((4 + 6)(-6)\)  
12. \(5(309)\)  
13. \(8(4.95)\)

Geometry Find the area of the rectangle or triangle.

14. \(x + 3\)  
15. \(4a - 5\)  
16. \(7 - c\)  
17. \(2n + 10\)

For the given expression, identify the terms, like terms, coefficients, and constant terms. Then simplify the expression.

18. \(4x + 2 + 5x\)  
19. \(-a + 3a + 7 - 4\)  
20. \(8k - 5 - 2k + 1\)  
21. \(y + 7y - 9 - 3y\)

Simplify the expression.

22. \(2(x - 7) - 3x\)  
23. \(-4(n + 1) + 15n\)  
24. \(8p + 4 - (p + 4)\)  
25. \(9t - 3(3t - 2)\)

Write the verbal sentence as an equation. Tell whether 12 is a solution.

26. The difference of 17 and \(x\) is 4.  
27. The quotient of \(a\) and 4 is 3.

Solve the equation.

28. \(x + 12 = 9\)  
29. \(-4 = h - 20\)  
30. \(-3r = 87\)  
31. \(\frac{s}{7} = 13\)

32. Books You buy a book that is 540 pages long. You can read about 30 pages per hour. How long does it take you to read the book?

Perform the indicated operation.

33. \(-3.1 + (-7.3)\)  
34. \(5.85 - 9.47\)  
35. \(-6.2(-0.9)\)  
36. \(7.15 \div (-1.3)\)

Solve the equation.

37. \(x + 6.5 = -4.5\)  
38. \(c - 2.59 = 1.48\)  
39. \(-9.12 = -2.4y\)  
40. \(\frac{m}{-3.4} = 8.3\)
Chapter Standardized Test

Test-Taking Strategy For difficult questions, first try eliminating answer choices that you know are not correct.

1. Which equation illustrates the identity property of multiplication?
   A. \((xy)z = x(yz)\)  B. \(x \cdot 0 = 0\)
   C. \(x \cdot 1 = x\)  D. \(x + 0 = x\)

2. The average height of a male giraffe is 17 feet. What is this height in inches?
   F. 29 inches  G. 51 inches
   H. 170 inches  I. 204 inches

3. Which expression represents the area (in square units) of the triangle shown?
   A. \(32x + 48\)  B. \(16x + 24\)
   C. \(4x + 14\)  D. \(32x + 6\)

4. Which number is not a coefficient of \(n\) in the expression \(3n + 8 = n + 4n\)?
   F. \(-1\)  G. \(1\)  H. \(3\)  I. \(4\)

5. Which expression is equivalent to \(5a + 8 - 2(a + 4)\)?
   A. \(3a\)  B. \(3a + 4\)
   C. \(3a + 12\)  D. \(3a + 16\)

6. Which equation represents the sentence “The difference of 9 and \(x\) is 5.”?
   F. \(9 = x - 5\)  G. \(9 = 5 - x\)
   H. \(9 - x = 5\)  I. \(x - 9 = 5\)

7. Which equation does not have 6 as a solution?
   A. \(t + 5 = 11\)  B. \(3 - t = -3\)
   C. \(7t = 42\)  D. \(\frac{24}{r} = 3\)

8. What is the solution of \(y + 31 = 19\)?
   F. \(-50\)  G. \(-12\)  H. \(12\)  I. \(50\)

9. What is the solution of \(-20 = g - 4\)?
   A. \(-24\)  B. \(-16\)  C. \(5\)  D. \(80\)

10. What is the solution of \(\frac{x}{-3} = -18\)?
    F. \(-54\)  G. \(-6\)  H. \(6\)  I. \(54\)

11. What is the value of \(-4.85 - (-6.32)\)?
    A. \(-11.17\)  B. \(-1.47\)
    C. \(1.47\)  D. \(11.17\)

12. What is the solution of \(5.2w = -2.08\)?
    F. \(-2.5\)  G. \(-0.4\)  H. \(0.4\)  I. \(2.5\)

13. Short Response Once a week, you either rent a movie for $4 or see a movie in a theater for $9. Let \(r\) represent the number of movies you rent in a year (52 weeks). Write and simplify an expression in terms of \(r\) for the total amount you spend on movies during the year.

14. Extended Response You have been hired to mow a rectangular lawn that is 300 feet long and 150 feet wide. You want to earn $12 per hour of work, and you can mow about 20,000 square feet per hour.
   a. What is the area of the lawn?
   b. About how long will it take you to mow the lawn?
   c. How much money should you charge for mowing the lawn?
Measuring Indirectly

Goal
Find the height of a stack of coins that is too high to be measured directly.

Key Skill
Indirect measurement

Materials
- at least ten pennies
- ruler
- calculator

One penny doesn’t amount to much. But suppose you could save one million pennies. Students in the Los Angeles area did just that during a school year and used the money to buy new computers for their school. Suppose you made a stack of one million pennies. How tall would the stack be? Would it be taller than the Empire State Building? taller than Mount Everest?

You cannot find the height of the stack with a ruler or any other common measuring tool. However, you can use indirect measurement to find the height.

Investigate

1. Stack at least ten pennies and use a ruler to measure the height of the stack in millimeters.

2. Use the following verbal model to write an equation.

   \[
   \text{Height of your stack} \times \frac{\text{Height of one penny}}{\text{Number of pennies in your stack}} = \text{Height of your stack}
   \]

3. Solve the equation that you wrote in Step 2 to find the height of one penny.

4. To find the height of a stack of one million pennies, multiply the height of one penny by 1,000,000.
Consider and Decide

Compare the height of a stack of one million pennies with the heights of the Empire State Building and Mount Everest. Consider the following:

- The Empire State Building is 381 meters tall. Mount Everest is 8850 meters tall.
- What unit of measurement did you use to write the height of a stack of one million pennies? Is this unit appropriate? Convert the unit if necessary.

Present Your Results

Write a short explanation of how you found the height of a stack of one million pennies. Include your measurements and equations. Describe how the height of the stack compares with the height of the Empire State Building and the height of Mount Everest.

Project Extensions

Research

The U.S. Mint produces coins. Use the Internet to find out how many pennies, nickels, dimes, and quarters were produced by the U.S. Mint last year. Find the total value (in dollars) of each coin type produced. Then find the combined value. Explain how you found your answers.

Experiment

Every day about 17 million $1 bills are printed, most of which are used to replace bills already in circulation. Use indirect measurement to find the thickness of a $1 bill. Suppose you made a stack of all the $1 bills printed in one day. How tall would this stack be? Explain the steps you took to find your answers.

Career

The U.S. Mint has facilities in Washington, D.C., San Francisco, Fort Knox, and other locations. Employees of the U.S. Mint work to produce and protect American currency. Find out more about careers at the U.S. Mint.