Yosemite National Park was created by Congress in 1890. An algebraic expression can model the current age of the park.
Vocabulary

Choose the best term from the list to complete each sentence.

1. The operation that gives the quotient of two numbers is __?
   division
   multiplication
   place value
   product
   quotient

2. The __?
   division
   multiplication
   place value
   product
   quotient
   of the digit 3 in 4,903,672 is thousands.

3. The operation that gives the product of two numbers is __?
   division
   multiplication
   place value
   product
   quotient

4. In the equation 15 ÷ 3 = 5, the __?
   division
   multiplication
   place value
   product
   quotient
   is 5.

Complete these exercises to review skills you will need for this chapter.

**Find Place Value**

Give the place value of the digit 4 in each number.

5. 4,092
6. 608,241
7. 7,040,002
8. 4,556,890,100

9. 3,408,289
10. 34,506,123
11. 500,986,402
12. 3,540,277,009

**Use Repeated Multiplication**

Find each product.

13. 2 • 2 • 2
14. 9 • 9 • 9 • 9
15. 14 • 14 • 14
16. 10 • 10 • 10 • 10

17. 3 • 3 • 5 • 5
18. 2 • 2 • 5 • 7
19. 3 • 3 • 11 • 11
20. 5 • 10 • 10 • 10

**Division Facts**

Find each quotient.

21. 49 ÷ 7
22. 54 ÷ 9
23. 96 ÷ 12
24. 88 ÷ 8

25. 42 ÷ 6
26. 65 ÷ 5
27. 39 ÷ 3
28. 121 ÷ 11

**Whole Number Operations**

Add, subtract, multiply, or divide.

29. 425
   + 12
30. 619
   + 254
31. 62
   − 47
32. 373
   + 86

33. 62
   × 42
34. 122
   × 15
35. 7623
   742
36. 24149
The information below “unpacks” the standards. The Academic Vocabulary is highlighted and defined to help you understand the language of the standards. Refer to the lessons listed after each standard for help with the math terms and phrases. The Chapter Concept shows how the standard is applied in this chapter.

<table>
<thead>
<tr>
<th>California Standard</th>
<th>Academic Vocabulary</th>
<th>Chapter Concept</th>
</tr>
</thead>
</table>
| AF1.1 Write and solve one-step linear equations in one variable. (Lessons 1-8, 1-9, 1-10, 1-11) (Lab 1-8) | **solve** find the value or values of an unknown quantity that make one side of an equation equal to the other side (make the equation true)  
**Example:**  
2 \( \cdot \) \( \) = 6  
2 \( \cdot \) 3 = 6  
**variable** a symbol, usually a letter, used to show an amount that can change  
**Example:** \( x \) | You write an equation that describes a situation.  
You find the value of a variable that makes an equation true.  
**Example:** \( 2x = 6 \)  
\( 2(3) = 6 \)  
The value that makes \( 2x = 6 \) true is 3. |
| AF1.2 Write and evaluate an algebraic expression for a given situation, using up to three variables. (Lessons 1-5, 1-6) | **expression** a mathematical phrase that includes numbers, operations, and/or variables  
**Example:** \( 4x + 3 \)  
**algebraic** an expression is algebraic if it includes at least one variable  
**Example:** \( 4x + 3 \)  
**evaluate** find the value of an algebraic expression | You find the value of an expression containing variables when you are given the values of its variables.  
**Example:** \( 4x \) for \( x = 2 \)  
\( 4x \)  
\( 4(2) \)  
\( 8 \) |
| AF1.3 Apply algebraic order of operations and the commutative, associative, and distributive properties to evaluate expressions; and justify each step in the process. (Lessons 1-3, 1-4, 1-5) (Lab 1-3) | **property** a characteristic of numbers, operations, or equations  
**Example:** One property of addition is that you can add numbers in any order without changing the sum.  
**justify** give a reason for | You use mathematical properties to find the value of expressions.  
You give reasons for each step when you find the value of expressions. |
| AF1.4 Solve problems manually by using the correct order of operations or by using a scientific calculator. (Lesson 1-3) (Lab 1-3) | **manually** by hand  
**operations** include addition, subtraction, multiplication, and division  
**scientific calculator** a calculator that does more than basic arithmetic operations, but cannot make graphs | You find the value of expressions by performing basic arithmetic operations in a certain order.  
**Example:** \( 10 + 4 \cdot 3 \)  
Multiply. \( 10 + 12 \)  
Then add. \( 22 \) |
Reading Strategy: Use Your Book for Success

Understanding how your textbook is organized will help you locate and use helpful information.

As you read through an example problem, pay attention to the margin notes, such as Reading Math notes, Writing Math notes, Helpful Hints, and Caution notes. These notes will help you understand concepts and avoid common mistakes.

The glossary is found in the back of your textbook. Use it to find definitions and examples of unfamiliar words or properties.

The index is located at the end of your textbook. Use it to find the page where a particular concept is taught.

The Skills Bank is found in the back of your textbook. These pages review concepts from previous math courses.

Try This

Use your textbook for the following problems.

1. Use the index to find the page where exponent is defined.
2. Use the glossary to find the definition of each term: order of operations, numerical expression, equation.
3. Where can you review how to multiply whole numbers?
4. On what page can you find answers to exercises in Chapter 1?
Identifying and Extending Number Patterns

Identify a possible pattern. Use your pattern to write the next three numbers.

A 64, 32, 16, 8, □, □, □, . . .

\[ \begin{align*}
64 & \div 2 = 32 \\
32 & \div 2 = 16 \\
16 & \div 2 = 8 \\
8 & \div 2 = 4 \\
4 & \div 2 = 2 \\
2 & \div 2 = 1
\end{align*} \]

A pattern is to divide each number by 2 to get the next number.

The next three numbers will be 4, 2, and 1.

B 51, 44, 37, 30, □, □, □, . . .

\[ \begin{align*}
51 & - 7 = 44 \\
44 & - 7 = 37 \\
37 & - 7 = 30 \\
30 & - 7 = 23 \\
23 & - 7 = 16 \\
16 & - 7 = 9
\end{align*} \]

A pattern is to subtract 7 from each number to get the next number.

The next three numbers will be 23, 16, and 9.

C 2, 3, 5, 8, 12, □, □, □, . . .

\[ \begin{align*}
2 & + 1 = 3 \\
3 & + 2 = 5 \\
5 & + 3 = 8 \\
8 & + 4 = 12 \\
12 & + 5 = 17 \\
17 & + 6 = 23 \\
23 & + 7 = 30
\end{align*} \]

A pattern is to add one more than you did the time before.

The next three numbers will be 17, 23, and 30.
EXAMPLE 2 Identifying and Extending Geometric Patterns

Identify a possible pattern. Use your pattern to draw the next three figures.

A pattern is alternating squares and circles with triangles between them.
The next three figures will be 🟥 🟡 🟢 🟠 🟡 🟢 🟠.

A pattern is to shade every other triangle in a clockwise direction.
The next three figures will be 🟢 🟢 🟢 🟢.

EXAMPLE 3 Using Tables to Identify and Extend Patterns

Make a table that shows the number of triangles in each figure. Tell how many triangles are in the fifth figure of a possible pattern. Use drawings to justify your answer.
The table shows the number of triangles in each figure.

<table>
<thead>
<tr>
<th>Figure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Triangles</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

A pattern is to add 2 triangles each time.

Figure 4 has \(6 + 2 = 8\) triangles. Figure 5 has \(8 + 2 = 10\) triangles.

Think and Discuss

1. Describe two different number patterns that begin with 3, 6, . . .

2. Tell when it would be useful to make a table to help you identify and extend a pattern.
GUIDED PRACTICE

1. Identify a possible pattern. Use your pattern to write the next three numbers.
   6, 14, 22, 30, □, □, □, . . .
   2. Identify a possible pattern. Use your pattern to draw the next three figures.
   3. 59, 50, 41, 32, □, □, □, . . .
   4. 8, 9, 11, 14, □, □, □, . . .

INDEPENDENT PRACTICE

1. Identify a possible pattern. Use your pattern to write the next three numbers.
   8. 27, 24, 21, 18, □, □, □, . . .
   9. 4,096, 1,024, 256, 64, □, □, □, . . .
   10. 1, 3, 7, 13, 21, □, □, □, . . .
   11. 14, 37, 60, 83, □, □, □, . . .

12. Identify a possible pattern. Use your pattern to draw the next three figures.

13. Make a table that shows the number of dots in each figure. Tell how many dots are in the sixth figure of a possible pattern. Use drawings to justify your answer.

Figure 1 Figure 2 Figure 3

14. Make a table that shows the number of dots in each figure. Tell how many dots are in the sixth figure of a possible pattern. Use drawings to justify your answer.

Figure 1 Figure 2 Figure 3 Figure 4

PRACTICE AND PROBLEM SOLVING

Use the rule to write the first five numbers in each pattern.
15. Start with 7; add 16 to each number to get the next number.
16. Start with 96; divide each number by 2 to get the next number.
17. Start with 50; subtract 2, then 4, then 6, and so on, to get the next number.
18. Reasoning Suppose the pattern 3, 6, 9, 12, . . . is continued forever. Will the number 100 appear in the pattern? Why or why not?
Identify a possible pattern. Use your pattern to find the missing numbers.

19. 3, 12, , 192, , , . . .  
20. 61, 55, , 43, , , 25, . . .  
22. 2, , 8, , 32, 64, , . . .  

23. Health  The table shows the target heart rate during exercise for athletes of different ages. Assuming the pattern continues, what is the target heart rate for a 40-year-old athlete? a 65-year-old athlete?

<table>
<thead>
<tr>
<th>Age</th>
<th>Heart Rate (beats per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>150</td>
</tr>
<tr>
<td>25</td>
<td>146</td>
</tr>
<tr>
<td>30</td>
<td>142</td>
</tr>
<tr>
<td>35</td>
<td>138</td>
</tr>
</tbody>
</table>

24. Draw the next three figures in each pattern.

25. Social Studies  In the ancient Mayan civilization, people used a number system based on bars and dots. Several numbers are shown below. Look for a pattern and write the number 18 in the Mayan system.

26. What's the Error?  A student was asked to write the next three numbers in the pattern 96, 48, 24, 12, . . . . The student’s response was 6, 2, 1. Describe and correct the student’s error.

27. Write About It  A school chess club meets every Tuesday during the month of March. March 1 falls on a Sunday. Explain how to use a number pattern to find all the dates when the club meets.

28. Challenge  Find the 83rd number in the pattern 5, 10, 15, 20, 25, . . . .

Spiral Standards Review

30. Multiple Choice  Which rule best describes the pattern 2, 6, 18, 54, 162, . . . ?

31. Short Response  What could be the next number in the pattern 9, 11, 15, 21, 29, 39, . . . ? Explain how you determined your answer.

Round each number to the nearest hundred thousand. (Previous course)

32. 4,224,315  33. 12,483,028  34. 8,072,339

Find each quotient. (Previous course)

35. 3,068 ÷ 26  36. 8,680 ÷ 35  37. 51,408 ÷ 136
A DNA molecule makes a copy of itself that is identical to the original. The molecules continue to split so that the two become four, the four become eight, and so on.

Each time DNA copies itself, the number of molecules doubles. After four copies, the number of molecules is $2^4$.

This multiplication can also be written as a power, using a base and an exponent. The exponent tells how many times to use the base as a factor.

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

**Who uses this?** Scientists can use exponents to determine the number of DNA molecules in a sample.

**California Standards**

Preparation for AF1.4

Solve problems manually by using the correct order of operations or by using a scientific calculator.

Also covered: Preparation for AF1.3

**Vocabulary**

- power
- exponent
- base

**Reading Math**

Read $5^2$ as “5 to the second power” or “5 squared.” Read $2^6$ as “2 to the sixth power.”
To express a whole number as a power, write the number as the product of equal factors. Then write the product using the base and an exponent. For example, \(10,000 = 10 \cdot 10 \cdot 10 \cdot 10 = 10^4\).

**Example 2**

**Expressing Whole Numbers as Powers**

Write each number using an exponent and the given base.

A. 49, base 7
   \[49 = 7 \cdot 7 = 7^2 \quad \text{7 is used as a factor 2 times.}\]

B. 81, base 3
   \[81 = 3 \cdot 3 \cdot 3 \cdot 3 = 3^4 \quad \text{3 is used as a factor 4 times.}\]

**Example 3**

**Earth Science Application**

The Richter scale measures an earthquake’s strength, or magnitude. Each category in the table is 10 times stronger than the next lower category. For example, a large earthquake is 10 times stronger than a moderate earthquake. How many times stronger is a great earthquake than a moderate one?

An earthquake with a magnitude of 6 is 10 times stronger than one with a magnitude of 5.

An earthquake with a magnitude of 7 is 10 times stronger than one with a magnitude of 6.

An earthquake with a magnitude of 8 is 10 times stronger than one with a magnitude of 7.

\[10 \cdot 10 \cdot 10 = 10^3 = 1,000\]

A great earthquake is 1,000 times stronger than a moderate one.

**Think and Discuss**

1. **Describe** a relationship between \(3^5\) and \(3^6\).
2. **Tell** which power of 8 is equal to \(2^6\). Explain.
3. ** Explain** why any number to the first power is equal to that number.
### GUIDED PRACTICE

#### See Example 1
Find each value.

1. \(2^5\)  
2. \(3^3\)  
3. \(6^2\)  
4. \(9^1\)  
5. \(10^6\)

#### See Example 2
Write each number using an exponent and the given base.

6. \(25, \text{ base } 5\)  
7. \(16, \text{ base } 4\)  
8. \(27, \text{ base } 3\)  
9. \(100, \text{ base } 10\)

#### See Example 3
**Earth Science** On the Richter scale, a great earthquake is 10 times stronger than a major one, and a major one is 10 times stronger than a large one. How many times stronger is a great earthquake than a large one?

### INDEPENDENT PRACTICE

#### See Example 1
Find each value.

11. \(11^2\)  
12. \(3^5\)  
13. \(8^3\)  
14. \(4^3\)  
15. \(3^4\)  
16. \(2^4\)  
17. \(5^1\)  
18. \(2^3\)  
19. \(5^3\)  
20. \(30^1\)

#### See Example 2
Write each number using an exponent and the given base.

21. \(81, \text{ base } 9\)  
22. \(4, \text{ base } 4\)  
23. \(64, \text{ base } 4\)  
24. \(7, \text{ base } 7\)  
25. \(32, \text{ base } 2\)  
26. \(128, \text{ base } 2\)  
27. \(1,600, \text{ base } 40\)  
28. \(2,500, \text{ base } 50\)  
29. \(100,000, \text{ base } 10\)

#### See Example 3
30. In a game, a contestant had a starting score of one point. He tripled his score every turn for four turns. Write his score after four turns as a power. Then find his score.

### PRACTICE AND PROBLEM SOLVING

Give two ways to represent each number using powers.

31. \(81\)  
32. \(16\)  
33. \(64\)  
34. \(729\)  
35. \(625\)

Compare. Write <, >, or =.

36. \(4^2 \square 15\)  
37. \(3^3 \square 3^2\)  
38. \(64 \square 4^3\)  
39. \(8^3 \square 7^4\)  
40. \(10,000 \square 10^5\)  
41. \(6^5 \square 3,000\)  
42. \(9^3 \square 3^6\)  
43. \(5^4 \square 7^3\)

44. To find the volume of a cube, find the third power of the length of an edge of the cube. What is the volume of a cube that is 6 inches long on an edge?

45. **Reasoning** Domingo decided to save $0.03 the first day and to triple the amount he saves each day. How much will he save on the seventh day?

46. **Science** A newborn panda cub weighs an average of 4 ounces. How many ounces might a one-year-old panda weigh if its weight doubles 8 times in one year?
47. **Social Studies** If the populations of the cities in the table double every 10 years, what will their populations be in 2034?

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yuma, AZ</td>
<td>86,070</td>
</tr>
<tr>
<td>Phoenix, AZ</td>
<td>1,421,298</td>
</tr>
</tbody>
</table>

48. **Critical Thinking** Is $2^5$ greater than or less than $3^3$? Explain your answer.

49. **Hobbies** Malia is making a quilt with a pattern of rings. In the center ring, she uses four stars. In each of the next three rings, she uses three times as many stars as in the one before. How many stars does she use in the fourth ring? Write the answer using a power and find its value.

Order each set of numbers from least to greatest.

50. 29, $2^3$, $6^2$, 16, $3^5$  
51. $4^3$, 33, $6^2$, $5^3$, $10^1$  
52. $7^2$, $2^4$, 80, $10^2$, $1^8$

53. 2, $1^8$, $3^4$, $16^1$, 0  
54. $5^2$, 21, $11^2$, $13^1$, $1^9$  
55. $2^5$, $3^3$, 9, $5^2$, $8^1$

56. **Science** The cells of some kinds of bacteria divide every 30 minutes. If you begin with a single cell, how many cells will there be after 1 hour? 2 hours? 3 hours?

57. **What’s the Error?** A student wrote 64 as $8 \cdot 2$. How did the student apply exponents incorrectly?

58. **Write About It** Explain why $6^3 \neq 3^6$.

59. **Challenge** What is the length of the edge of a cube if its volume is 1,000 cubic meters?

60. **Multiple Choice** What is the value of $4^6$?
   - A 24
   - B 1,024
   - C 4,096
   - D 16,384

61. **Multiple Choice** Which of the following is NOT equal to 64?
   - A $6^4$
   - B $4^3$
   - C $2^6$
   - D $8^2$

62. **Gridded Response** Simplify $2^3 + 3^2$.

63. **Money** The students at a middle school raised $612 by having a garage sale, $102 by having a car wash, and $294 by having a concert. The money will be divided equally among 12 charities. How much will each charity receive? (Previous course)

Identify a possible pattern. Use your pattern to write the next three numbers. (Lesson 1-1)

64. 100, 91, 82, 73, 64, . . .  
65. 17, 19, 22, 26, 31, . . .  
66. 2, 6, 18, 54, 162, . . .
**Order of Operations**

**Why learn this?** You put on your socks before you put on your shoes. In mathematics, as in life, some tasks must be done in a certain order.

A numerical expression is made up of numbers and operations. When simplifying a numerical expression, rules must be followed so that everyone gets the same answer. That is why mathematicians have agreed upon the order of operations.

**ORDER OF OPERATIONS**

1. Perform operations within grouping symbols.
2. Evaluate powers.
3. Multiply and divide in order from left to right.
4. Add and subtract in order from left to right.

**EXAMPLE 1**

Using the Order of Operations

Simplify each expression. Use the order of operations to justify your work.

**A** \[ 27 - 18 \div 6 \]

\[
27 - 18 \div 6 \\
27 - 3 \\
24
\]

**B** \[ 36 - 18 \div 2 \cdot 3 + 8 \]

\[
36 - 18 \div 2 \cdot 3 + 8 \\
36 - 9 \cdot 3 + 8 \\
36 - 27 + 8 \\
9 + 8 \\
17
\]

**C** \[ 5 + 6^2 \cdot 10 \]

\[
5 + 6^2 \cdot 10 \\
5 + 36 \cdot 10 \\
5 + 360 \\
365
\]
Using the Order of Operations with Grouping Symbols

**Example 2**

**Using the Reasoning**

Simplify each expression.

**A**

\[ 36 - (2 \cdot 6) \div 3 \]

1. Perform the operation in parentheses.
2. Divide.

\[ 36 - (2 \cdot 6) \div 3 \]

\[ 36 - 12 \div 3 \]

\[ 36 - 4 \]

\[ 32 \]

**B**

\[ [(4 + 12 \div 4) - 2]^3 \]

1. The parentheses are inside the brackets, so perform the operations inside the parentheses first.

\[ [(4 + 12 \div 4) - 2]^3 \]

\[ [(4 + 3) - 2]^3 \]

\[ [7 - 2]^3 \]

\[ 5^3 \]

\[ 125 \]

**Helpful Hint**

When an expression has a set of grouping symbols within a second set of grouping symbols, begin with the innermost set.

**Example 3**

**Career Application**

Maria works part-time in a law office, where she earns $20 per hour. The table shows the number of hours she worked last week. Simplify the expression \((6 + 5 \cdot 3) \cdot 20\) to find out how much money Maria earned last week.

<table>
<thead>
<tr>
<th>Day</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>6</td>
</tr>
<tr>
<td>Tuesday</td>
<td>5</td>
</tr>
<tr>
<td>Wednesday</td>
<td>5</td>
</tr>
<tr>
<td>Thursday</td>
<td>5</td>
</tr>
</tbody>
</table>

\[(6 + 5 \cdot 3) \cdot 20\]

1. Perform the operations in parentheses.
2. Add.
3. Multiply.

\[ (6 + 15) \cdot 20 \]

\[ 21 \cdot 20 \]

\[ 420 \]

Maria earned $420 last week.

**Think and Discuss**

1. **Apply** the order of operations to determine if the expressions \(3 + 4^2\) and \((3 + 4)^2\) have the same value.

2. **Give** the correct order of operations for simplifying \((5 + 3 \cdot 20) \div 13 + 3^2\).

3. **Determine** where grouping symbols should be inserted in the expression \(3 + 9 - 4 \cdot 2\) so that its value is 13.
1-3 Exercises

GUIDED PRACTICE

1. Simplify each expression. Use the order of operations to justify your work.

1. 43 + 16 ÷ 4
2. 28 – 4 • 3 ÷ 6 + 4
3. 25 – 4² ÷ 8

See Example 2

4. 26 – (7 • 3) + 2
5. (3² + 11) ÷ 5
6. 32 + 6(4 – 2²) + 8

See Example 3

7. Career Caleb earns $10 per hour. He worked 4 hours on Monday, Wednesday, and Friday. He worked 8 hours on Tuesday and Thursday. Simplify the expression (3 • 4 + 2 • 8) • 10 to find out how much Caleb earned in all.

INDEPENDENT PRACTICE

8. 3 + 7 • 5 – 1
9. 5 • 9 – 3
10. 3 – 2 + 6 • 2²

See Example 2

11. (3 • 3 – 3)² ÷ 3 + 3
12. 2⁵ – (4 • 5 + 3)
13. (3 ÷ 3) + 3 ÷ (3³ – 3)
14. 4³ ÷ 8 – 2
15. (8 – 2)² • (8 – 1)² ÷ 3
16. 9,234 ÷ [3 • 3(1 + 8³)]

See Example 3

17. Consumer Math Maki paid a $14 basic fee plus $25 a day to rent a car. Simplify the expression 14 + 5 • 25 to find out how much it cost her to rent the car for 5 days.

18. Consumer Math Enrico spent $20 per square yard for carpet and $35 for a carpet pad. Simplify the expression 35 + 20(16) to find out how much Enrico spent to carpet a room with an area of 16 square yards.

PRACTICE AND PROBLEM SOLVING

19. 90 – 36 × 2
20. 16 + 14 ÷ 2 – 7
21. 64 ÷ 2² + 4
22. 10 × (18 – 2) + 7
23. (9 – 4)² – 12 × 2
24. [1 + (2 + 5)²] × 2

Compare. Write <, >, or =.

25. 8 • 3 – 2 8 • (3 – 2)
26. (6 + 10) ÷ 2 6 + 10 ÷ 2
27. 12 ÷ 3 • 4 12 ÷ (3 • 4)
28. 18 + 6 – 2 18 + (6 – 2)
29. [6(8 – 3) + 2] 6(8 – 3) + 2
30. (18 – 14) ÷ (2 + 2) 18 – 14 ÷ 2 + 2

Reasoning Insert grouping symbols to make each statement true.

31. 4 • 8 – 3 = 20
32. 5 + 9 – 3 ÷ 2 = 8
33. 12 – 2² ÷ 5 = 20
34. 4 • 2 + 6 = 32
35. 4 + 6 – 3 ÷ 7 = 1
36. 9 • 8 – 6 ÷ 3 = 6

37. Bertha earned $8.00 per hour for 4 hours babysitting and $10.00 per hour for 5 hours painting a room. Simplify the expression 8 • 4 + 10 • 5 to find out how much Bertha earned in all.
38. **Consumer Math**  Mike bought a painting for $512. He sold it at an antique auction for 4 times the amount that he paid for it, and then he purchased another painting with half of the profit that he made. Simplify the expression \((512 \cdot 4 - 512) \div 2\) to find how much Mike paid for the second painting.

39. **Multi-Step**  Anelise bought four shirts and two pairs of jeans. She paid $6 in sales tax.
   a. Write an expression that shows how much she spent on shirts.
   b. Write an expression that shows how much she spent on jeans.
   c. Write and simplify an expression to show how much she spent on clothes, including sales tax.

40. **Choose a Strategy**  There are four children in a family. The sum of the squares of the ages of the three youngest children equals the square of the age of the oldest child. How old are the children?
   A 1, 4, 8, 9    B 1, 3, 6, 12    C 4, 5, 8, 10    D 2, 3, 8, 16

41. **Write About It**  Describe the order in which you would perform the operations to find the correct value of \([(2 + 4)^2 - 2 \cdot 3] \div 6\).

42. **Challenge**  Use the numbers 3, 5, 6, 2, 54, and 5 in that order to write an expression that has a value of 100.

---

### Spiral Standards Review

**AF1.3, AF1.4**

43. **Multiple Choice** Which operation should be performed first to simplify the expression \(18 - 1 \cdot 9 \div 3 + 8\)?
   A Addition    B Subtraction    C Multiplication    D Division

44. **Multiple Choice** Which expression does NOT simplify to 81?
   A \(9 \cdot (4 + 5)\)    B \(7 + 16 \cdot 4 + 10\)    C \(3 \cdot 25 + 2\)    D \(10^2 - 4 \cdot 5 + 1\)

45. **Multiple Choice** Quinton bought 2 pairs of jeans for $30 each and 3 pairs of socks for $5 each. Which expression can be simplified to determine the total amount Quinton paid for the jeans and socks?
   A \(2 \cdot 3(30 + 5)\)    B \((2 + 3) \cdot (30 + 5)\)    C \(2 \cdot (30 + 5) \cdot 3\)    D \(2 \cdot 30 + 3 \cdot 5\)

Identify a possible pattern. Use your pattern to write the next three numbers.  
(Lesson 1-1)  
46. 56, 60, 64, 68, 72, . . .  
47. 5, 10, 20, 40, 80, . . .  
48. 70, 63, 56, 49, 42, . . .

Find each value.  
(Lesson 1-2)  
49. \(8^6\)  
50. \(9^3\)  
51. \(4^5\)  
52. \(3^3\)  
53. \(7^1\)
Explore Order of Operations

Use with Lesson 1-3

**REMEMBER**
The order of operations
1. Perform operations within grouping symbols.
2. Evaluate powers.
3. Multiply and divide in order from left to right.
4. Add and subtract in order from left to right.

**Activity 1**

1. Simplify $6 + 4 \cdot 2$ using paper and pencil. Use the order of operations.
   
   $6 + 4 \cdot 2$
   
   $6 + 8$  *Multiply.*
   
   $14$  *Add.*

2. Simplify the expression using a scientific calculator.
   
   Scientific calculators automatically perform the order of operations. However, some other types of calculators do not.

   If the calculator performed the addition before the multiplication, the answer displayed on the screen would have been 20 instead of 14.

**Think and Discuss**

1. In what order would a scientific calculator perform the operations if you used it to simplify the expression $64 \div 8 - 2 \cdot 4$?

2. Is $4 + 5 \cdot 6$ equivalent to $5 \cdot 6 + 4$? Explain.

**Try This**

Simplify each expression with pencil and paper. Check your answers with a scientific calculator.

1. $20 - 3 \cdot 5$
2. $15 \cdot 6 + 13$
3. $2 + 7 \cdot 5 \cdot 4$
4. $50 \div 10 \cdot 2$
5. $90 \div 3 - 30$

Use a scientific calculator to simplify each expression.

6. $56 \cdot 113 \div 8 - 247$
7. $336 \cdot 42 + 17 \cdot 218$
8. $2,462 - 352 \div 11 \cdot 24$

Chapter 1 Algebraic Reasoning
Many calculators have an \( \times^2 \) key that allows you to find the square of a number. On calculators that do not have this key, or to use exponents other than 2, you can use the caret key, \(^\uparrow\). For example, to evaluate \( 3^5 \), press 3 \(^\uparrow\) 5, and then press \( \text{ENTER} \).

To enter grouping symbols on a calculator, use the \( (\) and \( ) \) keys.

### Activity 2

1. Simplify \( 4 \cdot 2^3 \) using paper and pencil. Then check your answer with a scientific calculator.

   First simplify the expression using paper and pencil.
   
   \[
   \begin{align*}
   4 \cdot 2^3 &= 4 \cdot 8 \quad \text{Evaluate the power.} \\
   &= 32 \quad \text{Multiply.}
   \end{align*}
   \]

   Then simplify \( 4 \cdot 2^3 \) using a scientific calculator.

   Scientific calculators automatically evaluate the power first. If you want to perform the multiplication first, you must put that operation inside parentheses.

2. Simplify \( (3 + 7) \cdot 2^2 \) using paper and pencil. Then check your answer with a scientific calculator.

   \[
   \begin{align*}
   (3 + 7) \cdot 2^2 &= [10 \cdot 2]^2 \quad \text{Perform the operation in parentheses.} \\
   &= 20^2 \quad \text{Perform the operation in brackets.} \\
   &= 400 \quad \text{Evaluate the power.}
   \end{align*}
   \]

   Then simplify \( (3 + 7) \cdot 2^2 \) using a scientific calculator. Enter both sets of grouping symbols by using the parentheses keys. Notice that both methods give the same answer.

3. Use a scientific calculator to simplify \( \frac{(2 + 5 \cdot 4)^3}{4^2} \).

### Think and Discuss

1. Is \( 2 + 5 \cdot 4^3 + 4^2 \) equivalent to \( (2 + 5 \cdot 4^3) + 4^2 \)? Explain.

### Try This

Simplify each expression with pencil and paper. Check your answers with a scientific calculator.

1. \( 3 \cdot 2^3 + 5 \)  
2. \( 3 \cdot (2^3 + 5) \)  
3. \( (3 \cdot 2)^2 \)  
4. \( 3 \cdot 2^2 \)  
5. \( 2^{(3 \cdot 2)} \)

Use a scientific calculator to simplify each expression. Round your answers to the nearest hundredth.

6. \( (2.1 + 5.6 \cdot 4^3) \div 6^4 \)  
7. \( [(2.1 + 5.6) \cdot 4^3] \div 6^4 \)  
8. \( [(8.6 - 1.5) \div 2^3] \div 5^2 \)
1-4 Properties of Numbers

Who uses this? Architects can use properties of numbers to find the area of floor plans. (See Exercise 41.)

Vocabulary
Commutative Property
Associative Property
Identity Property
Distributive Property

California Standards
AF1.3 Apply algebraic order of operations and the commutative, associative, and distributive properties to evaluate expressions; and justify each step in the process.

Identifying Properties of Addition and Multiplication
Tell which property is represented.

A. \(2 + (7 + 8) = (2 + 7) + 8\)
   \(2 + (7 + 8) = (2 + 7) + 8\) The numbers are regrouped.
   Associative Property

B. \(25 \cdot 1 = 25\)
   \(25 \cdot 1 = 25\) One of the factors is 1.
   Identity Property

C. \(x \cdot y = y \cdot x\)
   \(x \cdot y = y \cdot x\) The order of the variables is switched.
   Commutative Property

### Commutative Property

<table>
<thead>
<tr>
<th>Words</th>
<th>Numbers</th>
<th>Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>You can add numbers in any order and multiply numbers in any order.</td>
<td>(3 + 8 = 8 + 3) (5 \cdot 7 = 7 \cdot 5)</td>
<td>(a + b = b + a) (ab = ba)</td>
</tr>
</tbody>
</table>

### Associative Property

<table>
<thead>
<tr>
<th>Words</th>
<th>Numbers</th>
<th>Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>When you add or multiply, you can group the numbers together in any combination.</td>
<td>((4 + 5) + 1 = 4 + (5 + 1)) ((9 \cdot 2) \cdot 6 = 9 \cdot (2 \cdot 6))</td>
<td>((a + b) + c = a + (b + c)) ((a \cdot b) \cdot c = a \cdot (b \cdot c))</td>
</tr>
</tbody>
</table>

### Identity Property

<table>
<thead>
<tr>
<th>Words</th>
<th>Numbers</th>
<th>Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>The sum of 0 and any number is the number. The product of 1 and any number is the number.</td>
<td>(4 + 0 = 4) (8 \cdot 1 = 8)</td>
<td>(a + 0 = a) (a \cdot 1 = a)</td>
</tr>
</tbody>
</table>
You can use properties and mental math to rearrange or regroup numbers into combinations that are easier to work with.

**Example 2**

**Using Properties to Simplify Expressions**

Simplify each expression. Justify each step.

A. \(12 + 19 + 18\)

\[
12 + 19 + 18 = 19 + 12 + 18  \quad \text{Commutative Property}
\]

\[
= 19 + (12 + 18)  \quad \text{Associative Property}
\]

\[
= 19 + 30  \quad \text{Add.}
\]

\[
= 49
\]

B. \(25 \cdot 13 \cdot 4\)

\[
25 \cdot 13 \cdot 4 = 25 \cdot 4 \cdot 13  \quad \text{Commutative Property}
\]

\[
= (25 \cdot 4) \cdot 13  \quad \text{Associative Property}
\]

\[
= 100 \cdot 13  \quad \text{Multiply.}
\]

\[
= 1,300
\]

**Distributive Property**

<table>
<thead>
<tr>
<th>Numbers</th>
<th>(6 \cdot (9 + 14) = 6 \cdot 9 + 6 \cdot 14)</th>
<th>(8 \cdot (5 - 2) = 8 \cdot 5 - 8 \cdot 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>(a \cdot (b + c) = ab + ac)</td>
<td>(a \cdot (b - c) = ab - ac)</td>
</tr>
</tbody>
</table>

You can use the Distributive Property to multiply numbers mentally by breaking apart one of the numbers and writing it as a sum or difference.

**Example 3**

**Using the Distributive Property to Multiply Mentally**

Use the Distributive Property to find \(7(29)\).

Method 1

\[
7(29) = 7(20 + 9)
\]

\[
= (7 \cdot 20) + (7 \cdot 9)
\]

\[
= 140 + 63
\]

\[
= 203
\]

Method 2

\[
7(29) = 7(30 - 1)
\]

\[
= (7 \cdot 30) - (7 \cdot 1)
\]

\[
= 210 - 7
\]

\[
= 203
\]

**Think and Discuss**

1. **Describe** two different ways to simplify the expression \(7 \cdot (3 + 9)\).

2. **Explain** how the Distributive Property can help you find \(6 \cdot 102\) using mental math.
1-4 Exercises

**GUIDED PRACTICE**

See Example 1

Tell which property is represented.

1. \(1 + (6 + 7) = (1 + 6) + 7\)
2. \(1 \cdot 10 = 10\)
3. \(3 \cdot 5 = 5 \cdot 3\)
4. \(6 + 0 = 6\)
5. \(4 \cdot (4 \cdot 2) = (4 \cdot 4) \cdot 2\)
6. \(x + y = y + x\)

See Example 2

Simplify each expression. Justify each step.

7. \(8 + 23 + 2\)
8. \(2 \cdot (17 \cdot 5)\)
9. \((25 \cdot 11) \cdot 4\)
10. \(17 + 29 + 3\)
11. \(16 + (17 + 14)\)
12. \(5 \cdot 19 \cdot 20\)

See Example 3

Use the Distributive Property to find each product.

13. \(2(19)\)
14. \(5(31)\)
15. \((22)2\)
16. \((13)6\)
17. \(8(26)\)
18. \((34)6\)

**INDEPENDENT PRACTICE**

See Example 1

Tell which property is represented.

19. \(1 + 0 = 1\)
20. \(xyz = x \cdot (yz)\)
21. \(9 + (9 + 0) = (9 + 9) + 0\)
22. \(11 + 25 = 25 + 11\)
23. \(7 \cdot 1 = 7\)
24. \((16 \cdot 4) \cdot 2 = (4 \cdot 16) \cdot 2\)

See Example 2

Simplify each expression. Justify each step.

25. \(50 \cdot 16 \cdot 2\)
26. \(9 + 34 + 1\)
27. \(4 \cdot (25 \cdot 9)\)
28. \(27 + 28 + 3\)
29. \(20 + (63 + 80)\)
30. \(25 + 17 + 75\)

See Example 3

Use the Distributive Property to find each product.

31. \(9(15)\)
32. \((14)5\)
33. \((3)(58)\)
34. \((10)(42)\)
35. \((23)4\)
36. \((16)5\)

**PRACTICE AND PROBLEM SOLVING**

Write an example of each property using whole numbers.

37. Commutative Property
38. Identity Property
39. Associative Property
40. Distributive Property

41. **Architecture**  The figure shows the floor plan for a studio loft. To find the area of the loft, the architect multiplies the length and the width: \((14 + 8) \cdot 10\). Use the Distributive Property to find the area of the loft.

Simplify each expression. Justify each step.

42. \(32 + 26 + 43\)
43. \(50 \cdot 45 \cdot 4\)
44. \(5 + 16 + 25\)
45. \(35 \cdot 25 \cdot 20\)
Complete each equation. Then tell which property is represented.

46. \(5 + 16 = 16 + \underline{\phantom{10}}\)
47. \(15 \cdot 1 = \underline{\phantom{10}}\)
48. \(\underline{\phantom{2}} \cdot (4 + 7) = 3 \cdot 4 + 3 \cdot 7\)
49. \(20 + \underline{\phantom{10}} = 20\)
50. \(2 \cdot \underline{\phantom{1}} \cdot 9 = (2 \cdot 13) \cdot 9\)
51. \(8 + (\underline{\phantom{1}} + 4) = (8 + 8) + 4\)
52. \(2 \cdot (6 + 1) = 2 \cdot \underline{\phantom{1}} + 2 \cdot 1\)
53. \((12 - 9) \cdot \underline{\phantom{1}} = 12 \cdot 2 - 9 \cdot 2\)

54. **Sports** Janice wants to know the total number of games won by the Denver Nuggets basketball team over the three seasons shown in the table. What expression should she simplify? Explain how she can use mental math and the properties of this lesson to simplify the expression.

55. **What’s the Error?** A student simplified the expression \(6 \cdot (9 + 12)\) as shown. What is the student’s error?

56. **Write About It** Do you think there is a Commutative Property of Division? Give an example to explain your answer.

57. **Challenge** Use the Distributive Property to simplify \(\frac{1}{6} \cdot (36 + \frac{1}{2})\).

---

### Spiral Standards Review

**58. Multiple Choice** Which expression is equivalent to \((24 + 8) + 12\)?

- **A** \((24 - 8) - 12\)
- **B** \(24 + (8 + 12)\)
- **C** \((24 + 12) + (8 + 12)\)
- **D** \((24 \cdot 12) + (8 \cdot 12)\)

**59. Multiple Choice** Which number completes the equation \(12 \cdot (20 + 6) = 12 \cdot 20 + \underline{\phantom{1}} \cdot 6\)?

- **A** 1
- **B** 6
- **C** 12
- **D** 20

**60. Short Response** Show how to use the Distributive Property to simplify the expression \(8(27)\).

Compare. Write <, >, or =. *(Lesson 1-2)*

- 61. \(7^2 \underline{\phantom{1}} 50\)
- 62. \(10^3 \underline{\phantom{1}} 300\)
- 63. \(9^2 \underline{\phantom{1}} 6^3\)
- 64. \(2^4 \underline{\phantom{1}} 4^2\)

Simplify each expression. *(Lesson 1-3)*

- 65. \(25 + 5 - (6^2 - 7)\)
- 66. \(3^3 - (6 + 3)\)
- 67. \((4^2 + 5) \div 7\)
- 68. \((5 - 3)^2 \div (3^2 - 7)\)
Vocabulary

variable  
constant  
algebraic expression  
evaluate

**Why learn this?** You can use an algebraic expression to determine the year in which a person was a certain age.

The actor and director Ron Howard was born in 1954.

You can use a letter such as $a$ to represent Ron Howard’s age. When he turns $a$ years old, the year will be

$$\text{1954} + a.$$  

The letter $a$ has a value that can change, or vary. When a letter represents a number that can vary, it is called a **variable**. The year 1954 is a **constant** because the number cannot change.

An **algebraic expression** is an expression that contains at least one variable. For example, $1954 + a$ is an algebraic expression.

To **evaluate** an algebraic expression, substitute a number for the variable.

### Evaluating Algebraic Expressions

The expression $s + 7$ represents Nancy’s age when her sister is $s$ years old. Evaluate the expression for each value of $s$, and tell what the value of the expression means.

#### A $s = 3$  
$s + 7$

$3 + 7$  
$10$  
**Substitute 3 for $s$.**  
**Add.**

When her sister is 3 years old, Nancy is 10 years old.

#### B $s = 5$  
$s + 7$

$5 + 7$  
$12$  
**Substitute 5 for $s$.**  
**Add.**

When her sister is 5 years old, Nancy is 12 years old.
Multiplication and division of variables can be written in several ways, as shown in the table.

When evaluating expressions, use the order of operations.

<table>
<thead>
<tr>
<th>Multiplication</th>
<th>Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>7t · t</td>
<td>( \frac{q}{2} )</td>
</tr>
<tr>
<td>7(t) · t</td>
<td>( q \div 2 )</td>
</tr>
<tr>
<td>ab ( \cdot ) b</td>
<td>( \frac{s}{r} )</td>
</tr>
<tr>
<td>a(b) ( \cdot ) b</td>
<td>( s \div r )</td>
</tr>
</tbody>
</table>

**EXAMPLE 2**

Evaluating Expressions Involving Order of Operations

Evaluate each expression for the given value of the variable.

**A** \( 3x - 2 \) for \( x = 5 \)

\[
3(5) - 2 \\
15 - 2 \\
13
\]

Substitute 5 for \( x \).
Multiply.
Subtract

**B** \( n \div 2 + n \) for \( n = 4 \)

\[
4 \div 2 + 4 \\
2 + 4 \\
6
\]

Substitute 4 for \( n \).
Divide.
Add.

**C** \( 6y^2 + 2y \) for \( y = 2 \)

\[
6(2)^2 + 2(2) \\
6(4) + 2(2) \\
24 + 4 \\
28
\]

Substitute 2 for \( y \).
Evaluate the power.
Multiply.
Add.

**EXAMPLE 3**

Evaluating Expressions with More Than One Variable

Evaluate \( \frac{3}{n} + 2m - p \) for \( n = 3, m = 4, \) and \( p = 6 \).

\[
\frac{3}{3} + 2(4) - 6 \\
1 + 8 - 6 \\
3
\]

Substitute 3 for \( n, 4 \) for \( m, \) and 6 for \( p \).
Divide and multiply from left to right.
Add and subtract from left to right.

**Think and Discuss**

1. Write each expression another way.  
   a. \( 12x \)  
   b. \( \frac{4}{y} \)  
   c. \( \frac{3xy}{2} \)
2. Explain the difference between a variable and a constant.
1-5 Exercises

**GUIDED PRACTICE**

**See Example 1**

The expression $12d$ represents the number of eggs in $d$ dozen. Evaluate the expression for each value of $d$, and tell what the value of the expression means.

1. $d = 3$
2. $d = 2$
3. $d = 11$

**See Example 2**

Evaluate each expression for the given value of the variable.

4. $2x - 3$ for $x = 4$
5. $n \div 3 + n$ for $n = 6$
6. $5y^2 + 3y$ for $y = 2$

**See Example 3**

Evaluate each expression for the given values of the variables.

7. $\frac{8}{n} + 3m$ for $n = 2$ and $m = 5$
8. $5a - 3b + 5$ for $a = 4$ and $b = 3$

**INDEPENDENT PRACTICE**

**See Example 1**

The expression $\frac{q}{4}$ represents the number of dollars equal to $q$ quarters. Evaluate the expression for each value of $q$, and tell what the value of the expression means.

9. $q = 16$
10. $q = 36$
11. $q = 64$

**See Example 2**

Evaluate each expression for the given value of the variable.

12. $5y - 1$ for $y = 3$
13. $10b - 9$ for $b = 2$
14. $p \div 7 + p$ for $p = 14$
15. $n \div 5 + n$ for $n = 20$
16. $3x^2 + 2x$ for $x = 10$
17. $3c^2 - 5c$ for $c = 3$

**See Example 3**

Evaluate each expression for the given values of the variables.

18. $\frac{12}{n} + 7m$ for $n = 6$ and $m = 4$
19. $7p - 2t + 3$ for $p = 6$ and $t = 2$
20. $x - \frac{y}{4} + 20z$ for $x = 9$, $y = 4$, and $z = 5$

**PRACTICE AND PROBLEM SOLVING**

Evaluate each expression for the given values of the variables. Justify each step.

21. $22p \div 11 + p$ for $p = 3$
22. $q + q^2 + q \div 2$ for $q = 4$
23. $\frac{16}{k} + 7h$ for $k = 8$ and $h = 2$
24. $f \div 3 + f$ for $f = 18$
25. $3t \div 3 + t$ for $t = 13$
26. $9 + 3p - 5t + 3$ for $p = 2$ and $t = 1$
27. $3m + \frac{y}{5} - b$ for $m = 2$, $y = 35$, and $b = 7$

28. The expression $60m$ gives the number of seconds in $m$ minutes. Evaluate $60m$ for $m = 7$. How many seconds are there in 7 minutes?

29. **Money** Betsy has $n$ quarters. You can use the expression $0.25n$ to find the total value of her coins in dollars. What is the value of 18 quarters?
30. **Recreation** Yosemite National Park was created by Congress in 1890. The expression \( x - 1890 \) models the current age of the park in years, where \( x \) is the present year. What is the current age of the park?

31. **Science** The graph shows the changes of state for water.
   a. What is the boiling point of water in degrees Celsius?
   b. Use the expression \( 1.8c + 32 \) to find the boiling point of water in degrees Fahrenheit.

[Changes of State for Water diagram]

32. **What's the Error?** A student was asked to identify the variable in the expression \( 72x + 8 \). The student answered \( 72x \). What was the student’s error?

33. **Write About It** Explain why letters such as \( x \), \( p \), and \( n \) used in algebraic expressions are called variables. Use examples to illustrate your response.

34. **Challenge** Evaluate the expression \( \frac{x+y}{y-x} \) for \( x = 6 \) and \( y = 8 \).

35. **Multiple Choice** Which expression does NOT equal 15?
   - A. \( 3t \) for \( t = 5 \)
   - B. \( 3 + t \) for \( t = 12 \)
   - C. \( t ÷ 3 \) for \( t = 60 \)
   - D. \( t - 10 \) for \( t = 25 \)

36. **Multiple Choice** A group of 11 students go rock climbing at a local gym. It costs $12 per student plus $4 for each shoe rental. If only 8 students rent shoes, what is the total cost for the group to go climbing? Use the expression \( 12x + 4y \), where \( x \) represents the total number of students and \( y \) represents the number of students who rent shoes.
   - A. $132
   - B. $140
   - C. $164
   - D. $176

Simplify each expression. (Lesson 1-3)

37. \( 6^2 - 28 + 5 \)
38. \( 15 \cdot 2 + 64 \div 8 \)
39. \( 17 + 6^2 \cdot 2 \)
40. \( 28 \div 4 \cdot 7 + 20 \)

Use the Distributive Property to find each product. (Lesson 1-4)

41. \( 5(16) \)
42. \( (17)4 \)
43. \( 7(23) \)
44. \( (29)3 \)
Why learn this? You can write an expression to show the relationship between the weights of dogs.

A Great Dane weighs about 40 times as much as a Chihuahua. An expression for the weight of the Great Dane could be $40c$, where $c$ is the weight of the Chihuahua.

When solving real-world problems, you will need to translate words, or verbal expressions, into algebraic expressions.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Verbal Expressions</th>
<th>Algebraic Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>• add 3 to a number&lt;br&gt;• a number plus 3&lt;br&gt;• the sum of a number and 3&lt;br&gt;• 3 more than a number&lt;br&gt;• a number increased by 3</td>
<td>$n + 3$</td>
</tr>
<tr>
<td>−</td>
<td>• subtract 12 from a number&lt;br&gt;• a number minus 12&lt;br&gt;• the difference of a number and 12&lt;br&gt;• 12 less than a number&lt;br&gt;• a number decreased by 12&lt;br&gt;• take away 12 from a number&lt;br&gt;• a number less 12</td>
<td>$x - 12$</td>
</tr>
<tr>
<td>×</td>
<td>• 2 times a number&lt;br&gt;• 2 multiplied by a number&lt;br&gt;• the product of 2 and a number</td>
<td>$2m$ or $2 \cdot m$</td>
</tr>
<tr>
<td>÷</td>
<td>• 6 divided into a number&lt;br&gt;• a number divided by 6&lt;br&gt;• the quotient of a number and 6</td>
<td>$a ÷ 6$ or $\frac{a}{6}$</td>
</tr>
</tbody>
</table>

**Example 1**

Translating Verbal Expressions into Algebraic Expressions

Write each phrase as an algebraic expression.

A. the product of 20 and $t$  
   **product** means “multiply”  
   $20t$

B. 24 less than a number  
   **less than** means “subtract from”  
   $n - 24$
Write each phrase as an algebraic expression.

C. 4 times the sum of a number and 2
   \[4 \times (n + 2) = 4(n + 2)\]

EXAMPLE 2 Translating Real-World Problems into Algebraic Expressions

A. Jed reads \(p\) pages each day of a 200-page book. Write an algebraic expression for how many days it will take Jed to read the book. Then evaluate the expression for \(p = 25\), and tell what the value of the expression means.

You need to separate the total number of pages into equal parts. This involves division.

\[
\frac{\text{total number of pages}}{\text{pages read each day}} = \frac{200}{p}
\]

Write the expression.

\[
\frac{200}{p}
\]

Substitute 25 for \(p\).

\[
\frac{200}{25} = 8
\]

Divide.

It will take Jed 8 days to read the book if he reads 25 pages each day.

B. Adult tickets to a concert cost $24, teen tickets cost $20, and child tickets cost $16. Write an algebraic expression to show how much it costs for an adult tickets, \(t\) teen tickets, and \(c\) child tickets. Then evaluate the expression for \(a = 3\), \(t = 1\), and \(c = 2\), and tell what the value of the expression means.

Multiply to put equal parts together.

Cost of adult tickets: \(24a\)

Cost of teen tickets: \(20t\)

Cost of child tickets: \(16c\)

Add to put parts together.

Total cost: \(24a + 20t + 16c\)

\[24a + 20t + 16c\]

Write the expression.

\[24(3) + 20(1) + 16(2)\]

Substitute 3 for \(a\), 1 for \(t\), and 2 for \(c\).

\[72 + 20 + 32\]

Multiply from left to right.

\[124\]

Add.

The cost of 3 adult, 1 teen, and 2 child tickets is $124.

Think and Discuss

1. Write three different verbal expressions that can be represented by \(2 - y\).
Write each phrase as an algebraic expression.

1. the product of 7 and \( p \)  
2. 3 less than a number  
3. 12 divided into a number  
4. 3 times the sum of a number and 5

5. A used bookstore is selling American comics for $2 each and Japanese comics for $3 each. Write an algebraic expression to show the total cost of \( a \) American comics and \( j \) Japanese comics. Then evaluate the expression for \( a = 4 \) and \( j = 2 \), and tell what the value of the expression means.

Write each phrase as an algebraic expression.

6. the sum of 5 and a number  
7. 2 less than a number  
8. the quotient of a number and 8  
9. 9 times a number  
10. 10 less than the product of a number and 3

11. A roller coaster carries \( r \) passengers, and a Ferris wheel carries \( f \) passengers. Write an algebraic expression to show how many more passengers are riding on the roller coaster than on the Ferris wheel. Then evaluate the expression for \( r = 42 \) and \( f = 36 \), and tell what the value of the expression means.

Write each phrase as an algebraic expression.

12. \( m \) plus the product of 6 and \( n \)  
13. the quotient of 23 and \( u \) minus \( t \)  
14. 14 less than the quantity \( k \) times 6  
15. 2 times the sum of \( y \) and 5  
16. the quotient of 100 and the quantity 6 plus \( w \)  
17. 35 multiplied by the quantity \( r \) less 45

18. **Multi-Step** An ice machine can produce 17 pounds of ice in one hour.  
   a. Write an algebraic expression to describe the number of pounds of ice produced in \( n \) hours.  
   b. How many pounds of ice can the machine produce in 4 hours?

19. **Hobbies** Karen makes beaded jewelry. She uses 3 beads for a ring, 8 beads for a pin, and 15 beads for a bracelet. Write an algebraic expression to show the total number of beads she will need for \( r \) rings, \( p \) pins, and \( b \) bracelets.
Write a verbal expression for each algebraic expression.

20. \( h + 3 \)  
21. \( 90 \div y \)  
22. \( s - 405 \)  
23. \( 16t \)

24. \( 5(a - 8) \)  
25. \( 4p - 10 \)  
26. \( (r + 1) \div 14 \)  
27. \( \frac{m}{15} + 3 \)

28. **Science** Tiny and harmless, follicle mites live in our eyebrows and eyelashes. They are relatives of spiders. So like spiders, they have eight legs. Write an algebraic expression for the number of legs in \( m \) mites.

29. **Nutrition** The table shows the estimated number of grams of carbohydrates commonly found in various types of foods.

<table>
<thead>
<tr>
<th>Food</th>
<th>Carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 c skim milk</td>
<td>12 g</td>
</tr>
<tr>
<td>1 piece of fruit</td>
<td>15 g</td>
</tr>
<tr>
<td>1 slice of bread</td>
<td>15 g</td>
</tr>
<tr>
<td>1 oz lean meat</td>
<td>0 g</td>
</tr>
</tbody>
</table>

29. Write an algebraic expression for the number of grams of carbohydrates in \( y \) pieces of fruit and 1 cup of skim milk.

30. How many grams of carbohydrates are in a sandwich made from \( t \) ounces of lean meat and 2 slices of bread?

31. **What’s the Question?** Al has twice as many baseball cards as Frank and four times as many football cards as Joe. The expression \( 2x + 4y \) can be used to show the total number of baseball and football cards Al has. If the answer is \( y \), then what is the question?

32. **Write About It** If you are asked to compare two numbers, what two operations might you use? Why?

33. **Challenge** On June 7, 2006, one U.S. dollar was equivalent to \$1.116 in Canadian money. Write an algebraic expression for the number of U.S. dollars you could get for \( n \) Canadian dollars.

34. **Multiple Choice** Which verbal expression does NOT represent \( 9 - x \)?

- (A) \( x \) less than nine
- (B) \( x \) decreased by nine
- (C) subtract \( x \) from nine
- (D) the difference of nine and \( x \)

35. **Short Response** A room at the Oak Creek Inn costs \$104 per night for two people. There is a \$19 charge for each extra person. Write an algebraic expression that shows the cost for a family of four staying at the inn for \( x \) nights. Then evaluate your expression for 3 nights.

Simplify each expression. (Lesson 1-3)

36. \( 6 + 4 \div 2 \)  
37. \( 9 \cdot 1 - 4 \)  
38. \( 5^2 - 3 \)  
39. \( 24 \div 3 + 3^3 \)

40. Evaluate \( b - a^2 \) for \( a = 2 \) and \( b = 9 \). (Lesson 1-5)
Quiz for Lessons 1-1 Through 1-6

1-1 Numbers and Patterns
Identify a possible pattern. Use your pattern to write the next three numbers or figures.
1. 8, 15, 22, 29, . . .
2. 79, 66, 53, 40, . . .
3. [Visual representation of figures]

1-2 Exponents
Find each value.
4. $8^4$
5. $7^3$
6. $4^5$
7. $6^2$
8. The number of bacteria in a sample doubles every hour. How many bacteria cells will there be after 8 hours if there is one cell at the beginning? Write your answer as a power.

1-3 Order of Operations
Simplify each expression.
9. $8 - 14 + (9 - 2)$
10. $54 - 6 \cdot 3 + 4^2$
11. $4 - 24 \div 2^3$
12. $(4 + 3)^2 - 9$
13. Toshio paid $50 to join a health club plus $24 per month. Simplify the expression $50 + 24 \cdot 12$ to find out how much Toshio paid to use the health club for one year.

1-4 Properties of Numbers
Simplify each expression. Justify each step.
14. $29 + 50 + 21$
15. $5 \cdot 18 \cdot 20$
16. $34 + 62 + 36$
17. $3 \cdot 11 \cdot 20$

1-5 Evaluating Algebraic Expressions
Evaluate each expression for the given values of the variable.
18. $7(x + 4)$ for $x = 5$
19. $11 - n \div 3$ for $n = 6$
20. $p + 6t^2$ for $p = 11$ and $t = 3$

1-6 Writing Algebraic Expressions
Write each phrase as an algebraic expression.
21. the quotient of a number and 15
22. a number decreased by 13
23. 10 times the difference of $p$ and 2
24. 3 plus the product of a number and 8
25. A long-distance phone company charges a $2.95 monthly fee plus $0.14 for each minute. Write an algebraic expression to show the cost of calling for $t$ minutes in one month.
Focus on Problem Solving

 Decide what action each problem is asking you to take, and tell whether you must multiply or divide. Then explain your decision.

1. Judy plays the flute in the band. She practices for 3 hours every week. Judy practices only half as long as Angie, who plays the clarinet. How long does Angie practice playing the clarinet each week?

2. Each year, members of the band and choir are invited to join the bell ensemble for the winter performance. There are 18 bells in the bell ensemble. This year, each student has 3 bells to play. How many students are in the bell ensemble this year?

3. For every percussion instrument in the band, there are 4 wind instruments. If there are 48 wind instruments in the band, how many percussion instruments are there?

4. A group of 4 people singing together in harmony is called a quartet. At a state competition for high school choir students, 8 quartets from different schools competed. How many students competed in the quartet competition?
An **equation** is a mathematical statement that two quantities are equal. You can think of a correct equation as a balanced scale.

Equations may contain variables. If a value for a variable makes an equation true, that value is a **solution** of the equation. You can test a value to see if it is a solution of an equation by substituting the value for the variable.

### Example 1: Determining Solutions of Equations

Determine whether the given value of the variable is a solution.

**A**  
\[ a + 23 = 82 \]  for  \( a = 61 \)

\[
\begin{align*}
   a & = 61 \\
   a + 23 & = 82 \\
   61 + 23 & = \underline{84} \\
   \text{Substitute 61 for } a. \\
   84 & \neq 82 \\
   \text{Add.}
\end{align*}
\]

Since 84 \( \neq \) 82, 61 is not a solution to  \( a + 23 = 82 \).
Determine whether the given value of the variable is a solution.

B  
\[60 \div c = 6 \text{ for } c = 10\]

\[60 \div c = 6\]
\[60 \div 10 ? = 6\]  \(\text{Substitute 10 for } c.\)
\[6 \? = 6\]  \(\text{Divide.}\)

\[\begin{array}{c}
6 \\
\hline
6
\end{array}\]

Because \(6 = 6\), 10 is a solution to \(60 \div c = 6\).

You can use equations to check whether measurements given in different units are equal.

For example, there are 12 inches in one foot. If you have a measurement in feet, multiply by 12 to find the measurement in inches: \(12 \cdot \text{feet} = \text{inches}\), or \(12f = i\).

If you have one measurement in feet and another in inches, check whether the two numbers make the equation \(12f = i\) true.

**Science Application**

One science book states that a manatee can grow to be 13 feet long. According to another book, a manatee may grow to 156 inches. Determine if these two measurements are equal.

\[12f = i\]
\[12 \cdot 13 = 156\]  \(\text{Substitute.}\)
\[156 = 156\]  \(\text{Multiply.}\)

Because \(156 = 156\), 13 feet is equal to 156 inches.

**Think and Discuss**

1. **Tell** which of the following is the solution to \(y \div 2 = 9\): \(y = 14\), \(y = 16\), or \(y = 18\). How do you know?

2. **Give an example** of an equation with a solution of 15.
GUIDED PRACTICE

Determine whether the given value of the variable is a solution.

1. \( c + 23 = 48 \) for \( c = 35 \)
2. \( z + 31 = 73 \) for \( z = 42 \)
3. \( 96 = 130 - d \) for \( d = 34 \)
4. \( 85 = 194 - a \) for \( a = 105 \)
5. \( 75 + y = 5 \) for \( y = 15 \)
6. \( 78 \div n = 13 \) for \( n = 5 \)

7. **Social Studies**  An almanac states that the Minnehaha Waterfall in Minnesota is 53 feet tall. A tour guide said the Minnehaha Waterfall is 636 inches tall. Determine if these two measurements are equal.

INDEPENDENT PRACTICE

Determine whether the given value of the variable is a solution.

8. \( w + 19 = 49 \) for \( w = 30 \)
9. \( d + 27 = 81 \) for \( d = 44 \)
10. \( g + 34 = 91 \) for \( g = 67 \)
11. \( k + 16 = 55 \) for \( k = 39 \)
12. \( 101 = 150 - h \) for \( h = 49 \)
13. \( 89 = 111 - m \) for \( m = 32 \)
14. \( 116 = 144 - q \) for \( q = 38 \)
15. \( 92 = 120 - t \) for \( t = 28 \)
16. \( 80 \div b = 20 \) for \( b = 4 \)
17. \( 91 \div x = 7 \) for \( x = 12 \)
18. \( 55 \div j = 5 \) for \( j = 10 \)
19. \( 49 \div r = 7 \) for \( r = 7 \)

20. **Money**  Kent earns $6 per hour at his after-school job. One week, he worked 12 hours and received a paycheck for $66. Determine if Kent was paid the correct amount of money. (Hint: $6 \cdot \text{hours} = \text{total pay})

21. **Measurement**  The Eiffel Tower in Paris, France, is 300 meters tall. A student claims that it is 300,000 centimeters tall. Determine if these two measurements are equal. (Hint: 1 m = 100 cm)

PRACTICE AND PROBLEM SOLVING

Determine whether the given value of the variable is a solution.

22. \( 93 = 48 + u \) for \( u = 35 \)
23. \( 112 = 14 \times f \) for \( f = 8 \)
24. \( 13 = m \div 8 \) for \( m = 104 \)
25. \( 79 = z - 23 \) for \( z = 112 \)
26. \( 64 = l - 34 \) for \( l = 98 \)
27. \( 105 = p \times 7 \) for \( p = 14 \)
28. \( 94 \div s = 26 \) for \( s = 3 \)
29. \( v + 79 = 167 \) for \( v = 88 \)
30. \( m + 36 = 54 \) for \( m = 18 \)
31. \( x - 35 = 96 \) for \( x = 112 \)
32. \( 12y = 84 \) for \( y = 7 \)
33. \( 7x = 56 \) for \( x = 8 \)
34. **Estimation**  A large pizza has 8 slices. Determine if 6 large pizzas will be enough to feed 24 people, if each person eats 2 to 3 slices of pizza.
35. **Multi-Step** Rebecca has 17 one-dollar bills. Courtney has 350 nickels. Do
the two girls have the same amount of money? (*Hint:* First find how many
nickels are in a dollar.)

36. Replace each [ ] with a number that makes the equation correct.

- **36.** $4 + 1 = [ ] + 2$
- **37.** $2 + [ ] = 6 + 2$
- **38.** $[ ] - 5 = 9 - 2$
- **39.** $5(4) = 10([ ])$
- **40.** $3 + 6 = [ ] - 4$
- **41.** $12 \div 4 = 9 \div [ ]$

42. **Critical Thinking** Linda is building a rectangular playhouse. The width is
$x$ feet. The length is $x + 3$ feet. The distance around the base of the playhouse
is 36 feet. Is 8 the value of $x$? Explain.

43. **Reasoning** What should replace the question mark to keep the scale
balanced?

44. **Write About It** Explain how to determine if a value is a solution to an
equation.

45. **Challenge** Is $n = 4$ a solution for $n^2 + 79 = 88$? Explain.

46. **Multiple Choice** For which equation is $b = 8$ a solution?

- **A** $13 - b = 8$
- **B** $8 + b = 21$
- **C** $b - 13 = 21$
- **D** $b + 13 = 21$

47. **Multiple Choice** When Paul gets 53 more postcards, he will have 82 cards in his
collection. Solve the equation $n + 53 = 82$ to find how many postcards Paul has in
his collection now.

- **A** 135
- **B** 125
- **C** 29
- **D** 27

48. Simplify each expression. Justify each step. (*Lesson 1-4*)

- **48.** $25 \cdot 22 \cdot 4$
- **49.** $84 + (23 + 16)$
- **50.** $28 + 33 + 7$

51. A bus can carry 55 passengers. Write an algebraic expression for the number
of buses needed to carry $p$ passengers. (*Lesson 1-6*)

52. Velvet ribbon costs $3 per yard, and silk ribbon costs $4 per yard. Write an
algebraic expression for the total cost of $v$ yards of velvet ribbon and $s$ yards
of silk ribbon. (*Lesson 1-6*)
Model Solving Equations

Use with Lessons 1-8 and 1-10

**KEY**

- 1 = 1
- x = variable

**REMEMBER**

- In an equation, the expressions on both sides of the equal sign are equivalent.
- A variable can have any value that makes the equation true.

You can use balance scales and algebra tiles to model and solve equations.

**Activity**

1. Use a balance scale to model and solve the equation $3 + x = 11$.

   a. On the left side of the scale, place 3 unit weights and one variable weight. On the right side, place 11 unit weights. This models $3 + x = 11$.

   ![Balance Scale Model]

   
   $3 + x = 11$

   b. Remove 3 of the unit weights from each side of the scale to leave the variable weight by itself on one side.

   ![Balance Scale Model]

   
   $3 + x = 11$
   
   $-3$

   c. Count the remaining unit weights on the right side of the scale. This number represents the solution of the equation.

   ![Balance Scale Model]

   
   $x = 8$

The model shows that if $3 + x = 11$, then $x = 8$. 

**California Standards**

- AF1.1 Write and solve one-step linear equations in one variable.
2 Use algebra tiles to model and solve the equation $3y = 15$.

a. On the left side of the mat, place 3 variable tiles. On the right side, place 15 unit tiles. This models $3y = 15$.

b. Since there are 3 variable tiles, divide the tiles on each side of the mat into 3 equal groups.

c. Count the number of unit tiles in one of the groups. This number represents the solution of the equation.

The model shows that if $3y = 15$, then $y = 5$.

To check your solutions, substitute the variable in each equation with your solution. If the resulting equation is true, your solution is correct.

3 + $x = 11$  
3 + 8 $\neq 11$  
11 $\neq 11$ ✔

Think and Discuss

1. What operation did you use to solve the equation $3 + x = 11$ in 1? What operation did you use to solve $3y = 15$ in 2?

2. Compare using a balance scale and weights with using a mat and algebra tiles. Which method of modeling equations is more helpful to you? Explain.

Try This

Use a balance scale or algebra tiles to model and solve each equation.

1. $4x = 16$  
2. $3 + 5 = n$  
3. $5r = 15$  
4. $n + 7 = 12$

5. $y + 6 = 13$  
6. $8 = 2r$  
7. $9 = 7 + w$  
8. $18 = 6p$
Some surfers recommend that the length of a beginner's surfboard be 14 inches greater than the surfer's height. If a surfboard is 82 inches, how tall should the surfer be to ride it?

Let \( h \) stand for the surfer's height. You can use the equation \( h + 14 = 82 \).

The equation \( h + 14 = 82 \) can be represented as a balanced scale.

To find the value of \( h \), you need \( h \) by itself on one side of a balanced scale.

To get \( h \) by itself, first take away 14 from the left side of the scale. Now the scale is unbalanced.

To rebalance the scale, take away 14 from the other side.

Taking away 14 from both sides of the scale is the same as subtracting 14 from both sides of the equation.

\[
\begin{align*}
h + 14 &= 82 \\
-14 & \quad -14 \\
h &= 68
\end{align*}
\]

A surfer using an 82-inch surfboard should be 68 inches tall.

Subtracting a number is the inverse, or opposite, of adding that number. Inverse operations are operations that undo each other. If an equation contains addition, solve it by subtracting from both sides to “undo” the addition.
**EXAMPLE 1**

**Solving Equations by Subtracting**

Solve each equation. Check your answers.

**A**

\[ x + 62 = 93 \]

\[ \begin{align*}
   x + 62 &= 93 & \text{62 is added to } x. \\
   -62 &\quad -62 & \text{Subtract 62 from both sides to undo the addition.} \\
   x &= 31
\end{align*} \]

**Check**

\[ x + 62 = 93 \]

\[ 31 + 62 \overset{?}{=} 93 \quad \text{Substitute 31 for } x \text{ in the equation.} \]

\[ 93 \overset{?}{=} 93 \checkmark \quad 31 \text{ is the solution.} \]

**B**

\[ 81 = 17 + y \]

\[ \begin{align*}
   81 &= 17 + y & \text{17 is added to } y. \\
   -17 &\quad -17 & \text{Subtract 17 from both sides to undo the addition.} \\
   64 &= y
\end{align*} \]

**Check**

\[ 81 = 17 + y \]

\[ 81 \overset{?}{=} 17 + 64 \quad \text{Substitute 64 for } y \text{ in the equation.} \]

\[ 81 = 81 \checkmark \quad 64 \text{ is the solution.} \]

**EXAMPLE 2**

**Social Studies Application**

Dyersberg, Newton, and St. Thomas are located along Ventura Highway, as shown on the map. Find the distance \( d \) between Newton and Dyersberg.

The distance between Newton and Dyersberg is 19 miles.

**Think and Discuss**

1. **Tell** whether the solution of \( c + 4 = 21 \) will be less than 21 or greater than 21. Explain.

2. **Describe** how you could check your answer in Example 2.
GUIDED PRACTICE

Solve each equation. Check your answers.

1. \( x + 54 = 90 \)
2. \( 49 = 12 + y \)
3. \( n + 27 = 46 \)
4. \( 22 + t = 91 \)
5. \( 31 = p + 13 \)
6. \( c + 38 = 54 \)

7. Lou, Michael, and Georgette live on Mulberry Street, as shown on the map. Lou lives 10 blocks from Georgette. Georgette lives 4 blocks from Michael. How many blocks \( b \) does Michael live from Lou?

INDEPENDENT PRACTICE

Solve each equation. Check your answers.

8. \( x + 19 = 24 \)
9. \( 10 = r + 3 \)
10. \( s + 11 = 50 \)
11. \( b + 17 = 42 \)
12. \( 12 + m = 28 \)
13. \( z + 68 = 77 \)
14. \( 72 = n + 51 \)
15. \( g + 28 = 44 \)
16. \( 27 = 15 + y \)

17. What is the length \( l \) of a killer whale?

PRACTICE AND PROBLEM SOLVING

Solve each equation.

18. \( x + 12 = 16 \)
19. \( n + 32 = 39 \)
20. \( 23 + q = 34 \)
21. \( 52 + y = 71 \)
22. \( 73 = c + 35 \)
23. \( 93 = h + 15 \)
24. \( 125 = n + 85 \)
25. \( 87 = b + 18 \)
26. \( 12 + y = 50 \)
27. \( t + 17 = 43 \)
28. \( k + 9 = 56 \)
29. \( 25 + m = 47 \)
Write an equation for each statement.

30. The number of eggs $e$ increased by 3 equals 14.

31. The number of new photos taken $p$ added to 20 equals 36.

32. **Science** Temperature can be measured in degrees Fahrenheit, degrees Celsius, or kelvins. To convert from degrees Celsius to kelvins, add 273 to the Celsius temperature. Complete the table.

<table>
<thead>
<tr>
<th>Kelvins (K)</th>
<th>°C + 273 = K</th>
<th>Celsius (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Freezes</strong></td>
<td>273</td>
<td>°C + 273 = 273</td>
</tr>
<tr>
<td><strong>Body Temperature</strong></td>
<td>310</td>
<td>°C + 273 = 310</td>
</tr>
<tr>
<td><strong>Water Boils</strong></td>
<td>373</td>
<td>°C + 273 = 373</td>
</tr>
</tbody>
</table>

33. **History** In 1520, the explorer Ferdinand Magellan tried to measure the depth of the ocean. He weighted a 370 m rope and lowered it into the ocean. This rope was not long enough to reach the ocean floor. Suppose the depth at this location was 1,250 m. How much longer would Magellan’s rope have to have been to reach the ocean floor?

34. **Reasoning** Use data from your science book to write a problem that can be solved using an equation that contains addition. Solve your problem.

35. **Write About It** Why is adding a number the inverse of subtracting that number?

36. **Challenge** In the magic square at right, each row, column, and diagonal has the same sum. Find the values of $x, y,$ and $z$.

<table>
<thead>
<tr>
<th>7</th>
<th>61</th>
<th>$x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>37</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>$z$</td>
<td>67</td>
</tr>
</tbody>
</table>

---

**Spiral Standards Review**

<table>
<thead>
<tr>
<th><strong>37. Multiple Choice</strong></th>
<th>Pauline hit 6 more home runs than Danielle. Pauline hit 18 home runs. How many home runs did Danielle hit?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>12</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>18</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>38. Multiple Choice</strong></th>
<th>Which is the solution to the equation $79 + r = 118$?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>$r = 39$</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>$r = 52$</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>$r = 79$</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>$r = 197$</td>
</tr>
</tbody>
</table>

Evaluate the expression $9y - 3$ for each given value of the variable. *(Lesson 1-5)*

| **39. $y = 2$** | **40. $y = 6$** | **41. $y = 10$** | **42. $y = 18$** |

Write each phrase as an algebraic expression. *(Lesson 1-6)*

| **43. 7 less than $t$** | **44. the product of $m$ and 5** |
| **45. 12 minus the sum of $x$ and 10** | **46. 8 more than the quotient of $b$ and 10** |
| **47. the product of 24 and the quantity $w$ plus 7** |
When John F. Kennedy became president of the United States, he was 43 years old. He was 8 years younger than Abraham Lincoln was when Lincoln became president. How old was Lincoln when he became president?

Let \( a \) represent Abraham Lincoln’s age.

\[
\begin{align*}
\text{Abraham Lincoln’s age} & \quad - \quad 8 \\
\begin{array}{c}
\leftarrow a \\
\leftarrow 8 \\
\end{array} & \quad = \quad \begin{array}{c}
\rightarrow \text{John F. Kennedy’s age} \\
\rightarrow 43 \\
\end{array}
\end{align*}
\]

Remember that adding a number is the inverse of subtracting that number. When an equation contains subtraction, use addition to “undo” the subtraction. Add the same amount to both sides of the equation.

\[
\begin{align*}
a - 8 &= 43 \\
+ 8 &\quad + 8 \\
\hline \\
a &= 51
\end{align*}
\]

Abraham Lincoln was 51 years old when he became president.

**Example 1**

**Solving Equations by Adding**

**A.** Solve \( p - 2 = 5 \). Check your answer.

\[
\begin{align*}
p - 2 &= 5 \quad &2 \text{ is subtracted from } p. \\
+ 2 &\quad + 2 \quad &\text{Add 2 to both sides to undo} \\
p &= 7 \quad &\text{the subtraction.}
\end{align*}
\]

**Check**

\[
\begin{align*}
p - 2 &= 5 \\
7 - 2 &\overset{?}{=} 5 \quad &\text{Substitute 7 for } p \text{ in the equation.} \\
5 &\overset{?}{=} 5 \checkmark \quad &7 \text{ is the solution.}
\end{align*}
\]
**Think and Discuss**

1. **Tell** whether the solution of \(b - 14 = 9\) will be less than 9 or greater than 9. Explain.

2. **Explain** how you know what number to add to both sides of an equation containing subtraction.

**1-9 Exercises**

**GUIDED PRACTICE**

See Example 1

Solve each equation. Check your answers.

1. \(p - 8 = 9\)
2. \(3 = x - 16\)
3. \(a - 13 = 18\)
4. \(15 = y - 7\)
5. \(n - 24 = 9\)
6. \(39 = d - 2\)

**INDEPENDENT PRACTICE**

See Example 1

Solve each equation. Check your answers.

7. \(y - 18 = 7\)
8. \(8 = n - 5\)
9. \(a - 34 = 4\)
10. \(c - 21 = 45\)
11. \(a - 40 = 57\)
12. \(31 = x - 14\)
13. \(28 = p - 5\)
14. \(z - 42 = 7\)
15. \(s - 19 = 12\)
PRACTICE AND PROBLEM SOLVING

Solve each equation.

16. \( r - 57 = 7 \)
17. \( 11 = x - 25 \)
18. \( 8 = y - 96 \)
19. \( a - 6 = 15 \)
20. \( q - 14 = 22 \)
21. \( f - 12 = 2 \)
22. \( 18 = j - 19 \)
23. \( 109 = r - 45 \)
24. \( d - 8 = 29 \)
25. \( g - 71 = 72 \)
26. \( p - 13 = 111 \)
27. \( 13 = m - 5 \)

28. **Geography** Mt. Rainier, in Washington, has a higher elevation than Mt. Shasta. The difference between their elevations is 248 feet. What is the elevation of Mt. Rainier? Write an equation and solve.

29. **Social Studies** In 2004, the population of New York City was 5 million less than the population of Shanghai, China. The population of New York City was 8 million. Solve the equation \( 8 = s - 5 \) to find the population of Shanghai.

30. **Write About It** Suppose \( n - 15 \) is a whole number. What do you know about the value of \( n \)? Explain.

31. **What’s the Error?** Look at the student paper at right. What did the student do wrong? What is the correct answer?

32. **Challenge** Write “the difference between \( n \) and 16 is 5” as an algebraic equation. Then find the solution.

### Spiral Standards Review

33. **Multiple Choice** Which is a solution to the equation \( j - 39 = 93 \)?

- A \( j = 54 \)
- B \( j = 66 \)
- C \( j = 93 \)
- D \( j = 132 \)

34. **Short Response** When 17 is subtracted from a number, the result is 64. Write an equation that can be used to find the original number. Then find the original number.

Simplify each expression. Use the order of operations to justify your work. (Lesson 1-3)

35. \( 81 - 4 \times 3 + 18 \div (6 + 3) \)
36. \( 17 \times (5 - 3) + 16 \div 8 \)
37. \( 3^2 - (15 - 8) + 4 \times 5 \)

Solve each equation. (Lesson 1-8)

38. \( a + 3 = 18 \)
39. \( y + 7 = 45 \)
40. \( x + 16 = 71 \)
41. \( 87 = b + 31 \)
Nine-banded armadillos are always born in groups of 4. If you count 32 babies, what is the number of mother armadillos?

Let $m$ represent the number of mother armadillos. There will be $m$ equal groups of 4. You can use the equation $4m = 32$.

Dividing by a number is the inverse of multiplying by that number. To solve an equation that contains multiplication, use division to “undo” the multiplication.

\[
\frac{4m}{4} = \frac{32}{4}
\]

There are 8 mother armadillos.

Who uses this? Biologists can solve equations that contain multiplication to learn about animal populations.

California Standards

AF1.1 Write and solve one-step linear equations in one variable.

EXAMPLE 1

Solving Equations by Dividing

Solve each equation. Check your answers.

A \[3x = 12\]

\[3x = 12\]

\[3x = 12\] \[\div 3\]

\[x = 4\]

Check \[3x = 12\]

\[3(4) = 12\]

\[12 = 12 \checkmark\]

B \[8 = 4w\]

\[8 = 4w\]

\[8 = 4\]

\[w = \frac{8}{4}\]

\[w = 2\]

Check \[8 = 4w\]

\[8 = 4(2)\]

\[8 = 8 \checkmark\]
PROBLEM SOLVING APPLICATION

The area of a rectangle is 36 square inches. Its length is 9 inches. What is its width \( w \)?

1. Understand the Problem

The answer will be the width of the rectangle in inches.

List the important information:

- The area of the rectangle is 36 square inches.
- The length of the rectangle is 9 inches.

Draw a diagram to represent this information.

\[
\begin{array}{c}
9 \\
36 \\
w
\end{array}
\]

2. Make a Plan

You can write and solve an equation using the formula for area. To find the area of a rectangle, multiply its length by its width.

\[
A = \ell w
\]

\[
36 = 9w
\]

3. Solve

\[
36 = 9w
\]

\[
\frac{36}{9} = \frac{9w}{9}
\]

\[
4 = w
\]

So the width of the rectangle is 4 inches.

4. Look Back

Arrange 36 identical squares in a rectangle. The length is 9, so line up the squares in rows of 9. You can make 4 rows of 9, so the width of the rectangle is 4.

Think and Discuss

1. Tell what number you would use to divide both sides of the equation \( 15x = 60 \).

2. Tell whether the solution of \( 10c = 90 \) will be less than 90 or greater than 90. Explain.
GUIDED PRACTICE

See Example 1

Solve each equation. Check your answers.

1. \(7x = 21\)  
2. \(27 = 3w\)  
3. \(90 = 10a\)
4. \(56 = 7b\)  
5. \(3c = 33\)  
6. \(12 = 2n\)

See Example 2

7. The area of a rectangular deck is 675 square feet. The deck's width is 15 feet. What is its length \(l\)?

INDEPENDENT PRACTICE

See Example 1

Solve each equation. Check your answers.

8. \(12p = 36\)  
9. \(52 = 13a\)  
10. \(64 = 8n\)
11. \(20 = 5x\)  
12. \(6r = 30\)  
13. \(77 = 11t\)
14. \(14s = 98\)  
15. \(12m = 132\)  
16. \(9z = 135\)

See Example 2

17. Marcy spreads out a rectangular picnic blanket with an area of 24 square feet. Its width is 4 feet. What is its length \(l\)?

PRACTICE AND PROBLEM SOLVING

Solve each equation.

18. \(5y = 35\)  
19. \(18 = 2y\)  
20. \(54 = 9y\)  
21. \(15y = 120\)
22. \(4y = 0\)  
23. \(22y = 440\)  
24. \(3y = 63\)  
25. \(z - 6 = 34\)
26. \(6y = 114\)  
27. \(161 = 7y\)  
28. \(135 = 3y\)  
29. \(y - 15 = 3\)
30. \(81 = 9y\)  
31. \(4 + y = 12\)  
32. \(7y = 21\)  
33. \(a + 12 = 26\)
34. \(10x = 120\)  
35. \(36 = 12x\)  
36. \(s - 2 = 7\)  
37. \(15 + t = 21\)

38. Estimation Colorado is almost a perfect rectangle on a map. Its border from east to west is about 387 mi, and its area is about 104,247 mi\(^2\). Estimate the length of Colorado's border from north to south. (Area = length \(\times\) width)
Science Link

Arthropods make up the largest group of animals on Earth. They include insects, spiders, crabs, and centipedes. Arthropods have segmented bodies. In centipedes and millipedes, all of the segments are identical.

39. Centipedes have 2 legs per segment. They can have from 30 to 354 legs. Find a range for the number of segments a centipede can have.

40. Millipedes have 4 legs per segment. The record number of legs on a millipede is 752. How many segments did this millipede have?

Many arthropods have compound eyes. Compound eyes are made up of tiny bundles of identical light-sensitive cells.

41. A dragonfly has 7 times as many light-sensitive cells as a housefly. How many of these cells does a housefly have?

42. Find how many times more light-sensitive cells a dragonfly has than a butterfly.

43. Write About It A trapdoor spider can pull with a force that is 140 times its own weight. What other information would you need to find the spider’s weight? Explain.

44. Challenge There are about 6 billion humans in the world. Scientists estimate that there are a billion billion arthropods in the world. About how many times larger is the arthropod population than the human population?

Light-Sensitive Cells

<table>
<thead>
<tr>
<th>Number of cells</th>
<th>Dragonfly</th>
<th>Butterfly</th>
<th>Housefly</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

45. Multiple Choice Solve the equation $25x = 175$.

A $x = 5$  B $x = 6$  C $x = 7$  D $x = 8$

46. Multiple Choice The area of a rectangle is 42 square inches. Its width is 6 inches. What is its length?

A 5 inches  B 7 inches  C 9 inches  D 11 inches

Evaluate each expression for the given value of the variables. (Lesson 1-5)

47. $3r + 6p$ for $r = 11$ and $p = 6$  48. $x^2 - 5(y + 4)$ for $x = 7$ and $y = 2$

Solve each equation. (Lessons 1-8 and 1-9)

49. $b + 53 = 95$  50. $a - 100 = 340$  51. $n - 24 = 188$  52. $w + 20 = 95$
Japanese pearl divers go as deep as 165 feet underwater. At this depth, the pressure is much greater than at the water’s surface. Water pressure can be described using equations containing division.

Multiplying by a number is the inverse of dividing by that number. When an equation contains division, use multiplication to “undo” the division.

**EXAMPLE 1**  
Solving Equations by Multiplying

Solve each equation. Check your answers.

**A**

\[ \frac{y}{5} = 4 \]

\[ \frac{y}{5} = 4 \]

* y is divided by 5.

\[ 5 \cdot \frac{y}{5} = 5 \cdot 4 \]

\[ y = 20 \]

**Check**

\[ \frac{y}{5} = 4 \]

\[ \frac{20}{5} = 4 \]

\[ 4 = 4 \checkmark \]

* Substitute 20 for y in the equation.

* 20 is the solution.

**B**

\[ 12 = \frac{z}{4} \]

\[ 12 = \frac{z}{4} \]

* z is divided by 4.

\[ 4 \cdot 12 = 4 \cdot \frac{z}{4} \]

\[ 48 = z \]

**Check**

\[ 12 = \frac{z}{4} \]

\[ \frac{48}{4} = 12 \]

\[ 12 = 12 \checkmark \]

* Substitute 48 for z in the equation.

* 48 is the solution.
EXAMPLE 2

Science Application

Pressure is the amount of force exerted on an area. Pressure can be measured in pounds per square inch, or psi.

The pressure at the surface of the water is half the pressure at 30 ft underwater.

\[
\text{pressure at surface} = \frac{\text{pressure at 30 ft underwater}}{2}
\]

The pressure at the surface is 15 psi. What is the water pressure at 30 ft underwater?

Let \( p \) represent the pressure at 30 ft underwater.

\[
15 = \frac{p}{2} \quad \text{Substitute 15 for pressure at the surface.}
\]

\[
2 \cdot 15 = 2 \cdot \frac{p}{2} \quad \text{Multiply both sides by 2 to undo the division.}
\]

\[
30 = p
\]

The water pressure at 30 ft underwater is 30 psi.

Think and Discuss

1. Tell whether the solution of \( \frac{c}{10} = 70 \) will be less than 70 or greater than 70. Explain.

2. Describe how you would check your answer to Example 2.

3. Explain why \( 13 \cdot \frac{x}{13} = x \).

GUIDED PRACTICE

Solve each equation. Check your answers.

1. \( \frac{y}{4} = 3 \)  
2. \( 14 = \frac{z}{2} \)  
3. \( \frac{r}{9} = 7 \)  
4. \( \frac{s}{10} = \frac{4}{40} \)  
5. \( 12 = \frac{i}{3} \)  
6. \( 9 = \frac{x}{3} \)  
7. \( \frac{f}{12} = 5 \)  
8. \( \frac{g}{2} = 1 \)

9. Irene mowed the lawn and planted flowers. The amount of time she spent mowing the lawn was one-third the amount of time it took her to plant flowers. It took her 30 minutes to mow the lawn. Find the amount of time \( t \) Irene spent planting flowers.
INDEPENDENT PRACTICE

Solve each equation. Check your answers.

10. \( \frac{d}{3} = 12 \)  
11. \( \frac{c}{2} = 13 \)  
12. \( 7 = \frac{m}{7} \)  
13. \( \frac{g}{7} = 14 \)  
14. \( 6 = \frac{f}{4} \)  
15. \( \frac{x}{12} = 12 \)  
16. \( \frac{j}{20} = 10 \)  
17. \( 9 = \frac{r}{9} \)

18. The area of Danielle’s garden is one-twelfth the area of her entire yard. The area of the garden is 10 square feet. Find the area \( a \) of the yard.

PRACTICE AND PROBLEM SOLVING

Find the value of \( c \) in each equation.

19. \( \frac{c}{12} = 8 \)  
20. \( 4 = \frac{c}{9} \)  
21. \( \frac{c}{15} = 11 \)  
22. \( c + 21 = 40 \)  
23. \( 14 = \frac{c}{5} \)  
24. \( \frac{c}{4} = 12 \)  
25. \( \frac{c}{4} = 15 \)  
26. \( 5c = 120 \)

27. **Multi-Step** The Empire State Building is 381 m tall. At the Grand Canyon’s widest point, 76 Empire State Buildings would fit end to end. Write and solve an equation to find the width of the Grand Canyon at this point.

28. **Earth Science** You can estimate the distance of a thunderstorm in kilometers by counting the number of seconds between the lightning flash and the thunder and then dividing this number by 3. If a storm is 5 km away, how many seconds will you count between the lightning flash and the thunder?

29. **Reasoning** Write a problem about money that can be solved with an equation that contains division.

30. **Write About It** Use a numerical example to explain how multiplication and division by the same number undo each other.

31. **Challenge** A number halved and then halved again is equal to 2. What was the original number?

32. **Multiple Choice** Carl has \( n \) action figures in his collection. He wants to place them in 6 bins with 12 figures in each bin. Solve the equation \( \frac{n}{6} = 12 \) to determine the number of action figures Carl has.

\( \text{A} \) \( n = 2 \)  
\( \text{B} \) \( n = 6 \)  
\( \text{C} \) \( n = 18 \)  
\( \text{D} \) \( n = 72 \)

33. **Multiple Choice** Which equation does NOT have \( k = 28 \) as a solution?

\( \text{A} \) \( \frac{k}{14} = 2 \)  
\( \text{B} \) \( \frac{k}{7} = 4 \)  
\( \text{C} \) \( \frac{k}{28} = 1 \)  
\( \text{D} \) \( \frac{k}{6} = 12 \)

Solve each equation. (Lesson 1-9)

34. \( t - 14 = 20 \)  
35. \( b - 7 = 6 \)  
36. \( y - 25 = 17 \)  
37. \( m - 6 = 68 \)

Solve each equation. (Lesson 1-10)

38. \( 4r = 52 \)  
39. \( 8k = 128 \)  
40. \( 81 = 9p \)  
41. \( 119 = 17q \)
Quiz for Lessons 1-7 Through 1-11

1-7 Equations and Their Solutions
Determine whether the given value of the variable is a solution.
1. \( c - 13 = 54 \) for \( c = 67 \)  
2. \( 5r = 65 \) for \( r = 15 \)  
3. \( 48 \div x = 6 \) for \( x = 8 \)  
4. Brady buys 2 notebooks and should get $3 back in change. The cashier gives him 12 quarters. Determine if Brady was given the correct amount of change.

1-8 Solving Equations by Subtracting
Solve each equation. Check your answers.
5. \( p + 51 = 76 \)  
6. \( 107 = 19 + j \)  
7. \( 45 = s + 27 \)  
8. A large section of the original Great Wall of China is now in ruins. As measured today, the length of the wall is about 6,350 kilometers. When the length of the section now in ruins is included, the length of the wall is about 6,850 kilometers. Write and solve an equation to find the approximate length of the section of the Great Wall that is now in ruins.

1-9 Solving Equations by Adding
Solve each equation. Check your answers.
9. \( k - 5 = 17 \)  
10. \( 150 = p - 30 \)  
11. \( n - 24 = 72 \)  
12. A roller coaster in New Jersey is taller than a roller coaster in Ohio. The difference between their heights is 36 feet. The roller coaster in Ohio is 420 feet high. Write and solve an equation to find the height of the roller coaster in New Jersey.

1-10 Solving Equations by Dividing
Solve each equation. Check your answers.
13. \( 6f = 18 \)  
14. \( 105 = 5d \)  
15. \( 11x = 99 \)  
16. Taryn buys 8 identical glasses. Her total is $48 before tax. Write and solve an equation to find out how much Taryn pays per glass.

1-11 Solving Equations by Multiplying
Solve each equation. Check your answers.
17. \( \frac{10}{9} \)  
18. \( \frac{5}{6} \)  
19. \( \frac{r}{15} = 3 \)  
20. Paula is baking peach pies for a bake sale. Each pie requires 2 pounds of peaches. She bakes 6 pies. Write and solve an equation to find how many pounds of peaches Paula had to buy.
Have a Heart  Chuck’s family decides to begin a fitness program. Their doctor encourages each family member to determine his or her maximum heart rate and then exercise at a lower rate.

1. The table shows the recommended maximum heart rate for people of various ages. Describe the pattern in the table. Then find the maximum heart rate for Chuck’s father, who is 45 years old.

<table>
<thead>
<tr>
<th>Age</th>
<th>Rate (beats per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>210</td>
</tr>
<tr>
<td>15</td>
<td>205</td>
</tr>
<tr>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>25</td>
<td>195</td>
</tr>
<tr>
<td>30</td>
<td>190</td>
</tr>
<tr>
<td>35</td>
<td>185</td>
</tr>
</tbody>
</table>

2. There is another way to find a person’s maximum heart rate. The sum of the maximum heart rate, $h$, and the person’s age, $a$, should be 220. Write an equation that relates $h$ and $a$.

3. Chuck’s mother used the equation from problem 2 to determine that her maximum heart rate is 174 beats per minute. How old is Chuck’s mother?

4. Chuck’s mother counts the number of heartbeats in 10 seconds and multiplies by 6 to find her heart rate. Write and solve an equation to find the number of times her heart beats in 10 seconds when she is at her maximum heart rate.

5. The family doctor recommends warming up before exercise. The expression $110 - a / 2$ gives a warm-up heart rate based on a person’s age, $a$. Find the warm-up heart rate for Chuck’s mother.
Jumping Beans

You will need a grid that is 4 squares by 6 squares. Each square must be large enough to contain a bean. Mark off a 3-square by 3-square section of the grid. Place nine beans in the nine spaces, as shown below.

You must move all nine beans to the nine marked-off squares in the fewest number of moves.

Follow the rules below to move the beans.

1. You may move one space to any empty square in any direction.
2. You may jump over another bean in any direction to an empty square.
3. You may jump over one bean at a time as many times as you like.

Moving all the beans in ten moves is not too difficult, but can you do it in nine moves?

Trading Spaces

The purpose of the game is to replace the red counters with the yellow counters, and the yellow counters with the red counters, in the fewest moves possible. The counters must be moved one at a time in an L-shape. No two counters may occupy the same square.

A complete copy of the rules and a game board are available online.
**PROJECT Tri-Sided Equations**

Use a colorful file folder to prepare a three-sided review of algebra!

**Directions**

1. Close the file folder. Fold one side down to the folded edge. Turn the folder over and fold the other side down to the folded edge. **Figure A**

2. Open the folder. It will be divided into four sections. On the top section, cut off \( \frac{1}{4} \) inch from each edge. On the bottom section, make a 1 inch diagonal slit in the top left corner and in the top right corner. **Figure B**

3. Fold the folder so that the corners of the smaller top section fit into the slits. This will create your three-sided holder for notes. **Figure C**

4. Write the definition of an equation on one side of your note holder. Write the order of operations on another side. Write examples of expressions on the third side.

**Taking Note of the Math**

Glue a small pocket made from construction paper or card stock onto each side of your note holder. On rectangular slips of card stock, write problems that demonstrate your knowledge of equations, order of operations, and expressions. Store the note cards in the appropriate pockets.
Vocabulary

1. The __?__ tells how many times to use the __?__ as a factor.
2. A(n) __?__ is a mathematical phrase made up of numbers and operations.
3. A(n) __?__ is a mathematical statement that two expressions are equal in value.
4. A(n) __?__ consists of constants, variables, and operations.

1-1 Numbers and Patterns (pp. 6–9)

Example

Identify a possible pattern. Use your pattern to write the next three numbers.

2, 8, 14, 20, . . .

2 + 6 = 8   8 + 6 = 14   14 + 6 = 20

A possible pattern is to add 6 each time.

20 + 6 = 26   26 + 6 = 32   32 + 6 = 38

Exercises

Identify a possible pattern. Use your pattern to write the next three numbers.

5. 6, 10, 14, 18, . . .
6. 15, 35, 55, 75, . . .
7. 7, 14, 21, 28, . . .
8. 8, 40, 200, 1,000, . . .
9. 41, 37, 33, 29, . . .
10. 68, 61, 54, 47, . . .

1-2 Exponents (pp. 10–13)

Example

Find the value of $4^3$.

$4^3 = 4 \cdot 4 \cdot 4 = 64$

Exercises

Find each value.

11. $9^2$
12. $10^1$
13. $2^7$
14. $1^7$
15. $11^2$
16. $3^3$
1-3 Order of Operations (pp. 14–17)  
**EXAMPLE**

- Simplify $(18 + 6) \cdot 5$.
  
  $(18 + 6) \cdot 5 = 24 \cdot 5 = 120$

**EXERCISES**

Simplify each expression.

17. $2 + (9 - 6) \div 3$
18. $12 \cdot 3^2 - 5$
19. $11 + 2 \cdot 5 - (9 + 7)$
20. $75 \div 5^2 + 8^2$

1-4 Properties of Numbers (pp. 20–23)  
**EXAMPLE**

- Tell which property is represented.
  
  $(10 \cdot 13) \cdot 28 = 10 \cdot (13 \cdot 28)$
  
  Associative Property

**EXERCISES**

Tell which property is represented.

21. $42 \div 17 = 17 \div 42$
22. $6 \cdot (x - 5) = 6 \cdot x - 6 \cdot 5$

1-5 Evaluating Algebraic Expressions (pp. 24–27)  
**EXAMPLE**

- Evaluate $5a - 6b + 7$ for $a = 4$ and $b = 3$.
  
  $5a - 6b + 7$
  $5(4) - 6(3) + 7$
  $20 - 18 + 7$
  $9$

**EXERCISES**

Evaluate each expression for the given values of the variables.

23. $4x - 5$ for $x = 6$
24. $8y^3 + 3y$ for $y = 4$
25. $\frac{n}{5} + 6m - 3$ for $n = 5$ and $m = 2$

1-6 Writing Algebraic Expressions (pp. 28–31)  
**EXAMPLE**

- Write as an algebraic expression.
  
  5 times the sum of a number and 6
  
  $5(n + 6)$

**EXERCISES**

Write as an algebraic expression.

26. 4 divided by the sum of a number and 12
27. 2 times the difference of $t$ and 11

1-7 Equations and Their Solutions (pp. 34–37)  
**EXAMPLE**

- Determine whether the given value of the variable is a solution.
  
  $f + 14 = 50$ for $f = 34$
  
  $34 + 14 = 50$  
  Substitute 34 for $f$.
  
  $48 \neq 50$  
  Add.
  
  34 is not a solution.

**EXERCISES**

Determine whether the given value of each variable is a solution.

28. $28 + n = 39$ for $n = 11$
29. $12t = 74$ for $t = 6$
30. $y - 53 = 27$ for $y = 80$
1-8 Solving Equations by Subtracting  (pp. 40–43)

**EXAMPLE**

- Solve the equation \( x + 18 = 31 \).
  
  \[
  \begin{align*}
  x + 18 &= 31 \\
  -18 &\quad -18 \\
  x &= 13
  \end{align*}
  \]

  18 is added to \( x \).

  Subtract 18 from both sides to undo the addition.

**EXERCISES**

Solve each equation.

1. \( 4 + x = 10 \)
2. \( n + 10 = 24 \)
3. \( c + 71 = 100 \)
4. \( y + 16 = 22 \)
5. \( 44 = p + 17 \)
6. \( 94 + w = 103 \)
7. \( 23 + b = 34 \)
8. \( 56 = n + 12 \)
9. \( 39 = 23 + p \)
10. \( d + 28 = 85 \)

1-9 Solving Equations by Adding  (pp. 44–46)

**EXAMPLE**

- Solve the equation \( c - 7 = 16 \).
  
  \[
  \begin{align*}
  c - 7 &= 16 \\
  +7 &\quad +7 \\
  c &= 23
  \end{align*}
  \]

  7 is subtracted from \( c \).

  Add 7 to each side to undo the subtraction.

**EXERCISES**

Solve each equation.

11. \( 28 = k - 17 \)
12. \( d - 8 = 1 \)
13. \( p - 55 = 8 \)
14. \( n - 31 = 36 \)
15. \( 3 = r - 11 \)
16. \( 97 = w - 47 \)
17. \( 12 = h - 48 \)
18. \( 9 = p - 158 \)

1-10 Solving Equations by Dividing  (pp. 47–50)

**EXAMPLE**

- Solve the equation \( 6x = 36 \).
  
  \[
  \begin{align*}
  6x &= 36 \\
  6 &\quad \div 6 \\
  x &= 6
  \end{align*}
  \]

  6 is multiplied by \( x \).

  Divide both sides by 6 to undo the multiplication.

**EXERCISES**

Solve each equation.

19. \( 5v = 40 \)
20. \( 27 = 3y \)
21. \( 12c = 84 \)
22. \( 18n = 36 \)
23. \( 72 = 9s \)
24. \( 11t = 110 \)
25. \( 7a = 56 \)
26. \( 8y = 64 \)

1-11 Solving Equations by Multiplying  (pp. 51–53)

**EXAMPLE**

- Solve the equation \( \frac{k}{4} = 8 \).
  
  \[
  \begin{align*}
  \frac{k}{4} &= 8 \\
  4 &\quad \times \frac{k}{4} = 4 \times 8 \\
  k &= 32
  \end{align*}
  \]

  \( k \) is divided by 4.

  Multiply both sides by 4 to undo the division.

**EXERCISES**

Solve each equation.

27. \( \frac{r}{7} = 6 \)
28. \( \frac{t}{5} = 3 \)
29. \( 6 = \frac{y}{3} \)
30. \( 12 = \frac{n}{6} \)
31. \( \frac{z}{13} = 4 \)
32. \( 20 = \frac{b}{5} \)
33. \( \frac{n}{11} = 7 \)
34. \( 10 = \frac{p}{9} \)
Identify a possible pattern. Use your pattern to write the next three numbers.

1. 24, 32, 40, 48, . . .
2. 6, 18, 54, 162, . . .
3. 64, 58, 52, 46, . . .
4. 13, 30, 47, 64, . . .

Find each value.

5. $6^2$
6. $7^5$
7. $8^6$
8. $3^5$

Simplify each expression.

9. $18 \cdot 3 + 3^3$
10. $36 + 16 - 50$
11. $149 - (2^8 - 200)$
12. $(4 \div 2) \cdot 9 + 11$

Simplify each expression. Justify each step.

13. $91 + 63 + 9$
14. $38 + (12 + 157)$
15. $200 \cdot 14 \cdot 5$

Evaluate each expression for the given values of the variables.

16. $4a + 6b + 7$ for $a = 2$ and $b = 3$
17. $7y^2 + 7y$ for $y = 3$
18. $4m + n(26 - p)$ for $m = 10$, $n = 6$, and $p = 4$

Write each phrase as an algebraic expression.

19. a number increased by 12
20. the quotient of a number and 7
21. 5 less than the product of 7 and s
22. the difference between 3 times $x$ and 4
23. There are more reptile species than amphibian species. There are 3,100 living species of amphibians. Write an expression to show how many more reptile species there are than amphibian species.

Solve each equation.

24. $x + 9 = 19$
25. $21 = y - 20$
26. $m - 54 = 72$
27. $136 = y + 114$
28. $16 = \frac{y}{3}$
29. $102 = 17y$
30. $\frac{r}{7} = 1,400$
31. $6x = 42$

32. An Olympic skater bought a pair of skate blades and a pair of skate boots for a total of $1,016. The blades cost $442. Write and solve an equation to find the cost of the boots.

33. The male Siberian tiger at a zoo is heavier than the male Bengal tiger. The difference in their weights is 140 pounds. The Bengal tiger weighs 480 pounds. Write and solve an equation to find the weight of the Siberian tiger.

34. A caterer charged $15 per person for a banquet. The total charge was $1,530. Write and solve an equation to find the number of people who attended.

35. A scientist is studying corn plants. She divides the plants into 6 equal groups, with 28 plants in each group. Write and solve an equation to find the total number of plants.
Multiple Choice: Eliminate Answer Choices

With some multiple-choice test items, you can use mental math or number sense to quickly eliminate some of the answer choices before you begin solving the problem.

**EXAMPLE 1**

Which is the solution to the equation \( x + 7 = 15 \)?

\[
\begin{align*}
\text{A} & : x = 22 \\
\text{B} & : x = 15 \\
\text{C} & : x = 8 \\
\text{D} & : x = 7
\end{align*}
\]

READ the question. Then try to eliminate some of the answer choices.

Use number sense:

Since \( x + 7 = 15 \), 15 must be greater than \( x \), or \( x \) must be less than 15. Since 22 and 15 are not less than 15, you can eliminate answer choices A and B.

The correct answer choice is C.

**EXAMPLE 2**

What is the value of the expression \( 18x + 6 \) for \( x = 5 \)?

\[
\begin{align*}
\text{A} & : 90 \\
\text{B} & : 96 \\
\text{C} & : 191 \\
\text{D} & : 198
\end{align*}
\]

LOOK at the choices. Then try to eliminate some of the answer choices.

Use mental math:

Estimate the value of the expression. Round 18 to 20 to make the multiplication easier.

\[
\begin{align*}
20x + 6 & \\
20(5) + 6 & \text{ Substitute 5 for} \ x. \\
106 & \text{ Multiply. Then add.}
\end{align*}
\]

Because you rounded up, the value of the expression should be less than 106. You can eliminate choices C and D because they are too large.

The correct answer choice is B.
Read each test item and answer the questions that follow.

**Item A**
During the August back-to-school sale, 2 pairs of shoes cost $34, a shirt costs $15, and a pair of pants costs $27. Janet bought 2 pairs of shoes, 4 shirts, and 4 pairs of pants and then paid an additional $7 for tax. Which expression shows the total that Janet spent?

A) $34 + 4(15 + 27)
B) $34 + 4(15 + 27) + 7
C) $4(34 + 15 + 27) + 7
D) $34 + 15 + 4\cdot 27

1. Can any of the answer choices be eliminated immediately? If so, which choices and why?
2. Describe how you can determine the correct answer from the remaining choices.

**Item B**
Anthony saved $1 from his first paycheck, $2 from his second paycheck, then $4, $8, and so on. How much money did Anthony save from his tenth paycheck?

A) $10
B) $16
C) $512
D) $1,023

3. Are there any answer choices you can eliminate immediately? If so, which choices and why?
4. What common error was made in finding answer choice A?

**Item C**
Craig has three weeks to read an 850-page book. Which equation can be used to find the number of pages Craig has to read each day?

A) \( \frac{x}{3} = 850 \)
B) \( 21x = 850 \)
C) \( 3x = 850 \)
D) \( \frac{x}{21} = 850 \)

5. Describe how to use number sense to eliminate at least one answer choice.
6. What common error was made in finding answer choice D?

**Item D**
What value of \( t \) makes the following equation true?

\[ 22t = 132 \]

A) 6
B) 110
C) 154
D) 2,904

7. Which choices can be eliminated by using number sense? Explain.
8. What common error was made in finding answer choice D?
9. Describe how you could check your answer to this problem.

**Item E**
What is the value of the expression \((1 + 2)^2 + 14 \div 2 + 5\)?

A) 0
B) 11
C) 17
D) 21

10. Use mental math to quickly eliminate one answer choice. Explain your choice.
11. What common error was made in finding answer choice B?
12. What common error was made in finding answer choice C?
Cumulative Assessment, Chapter 1

Multiple Choice

1. Which expression has a value of 74 when \(x = 10\), \(y = 8\), and \(z = 12\)?
   - A. \(4xyz\)
   - B. \(x + 5y + 2z\)
   - C. \(2xz - 3y\)
   - D. \(6xyz + 8\)

2. What is the value of the expression \(16 - 2^2\)?
   - A. 8
   - B. 10
   - C. 14
   - D. 42

3. A contractor charges $22 to install one miniblind. How much does the contractor charge to install \(m\) miniblinds?
   - A. \(22m\)
   - B. \(m/22\)
   - C. \(22 + m\)
   - D. \(22/m\)

4. Which of the following is an example of the Commutative Property?
   - A. \(20 + 10 = 2(10 + 5)\)
   - B. \(20 + 10 = 10 + 20\)
   - C. \(5 + (20 + 10) = (5 + 20) + 10\)
   - D. \(20 + 0 = 20\)

5. Which expression is equivalent to \(16(200 + 18)\)?
   - A. \(16 + (200 \cdot 18)\)
   - B. \(16(200) + 16(18)\)
   - C. \(200(16 + 18)\)
   - D. \(16(200) + 18(200)\)

6. What is the solution to the equation \(810 = x - 625\)?
   - A. \(x = 185\)
   - B. \(x = 215\)
   - C. \(x = 845\)
   - D. \(x = 1,435\)

7. Damaris buys 4 tubes of watercolor paint and 2 large tubes of oil paint. Which expression can be used to determine the total cost of Damaris’s paint?
   - A. \((4 + 2) \cdot (7 + 13)\)
   - B. \((4 \cdot 2) + (7 \cdot 13)\)
   - C. \(4 + 7 \cdot 2 + 13\)
   - D. \(4 \cdot 7 + 2 \cdot 13\)

8. To make a beaded necklace, Kris needs 88 beads. If Kris has 1,056 beads, how many necklaces can she make?
   - A. 968
   - B. 12
   - C. 264
   - D. 8

   - A. Add 4.
   - B. Add 9.
   - C. Multiply by 4.
   - D. Multiply by 9.

10. Marc spends $78 for \(n\) shirts. Which expression can be used to represent the cost of one shirt?
    - A. \(\frac{n}{78}\)
    - B. \(78n\)
    - C. \(\frac{78}{n}\)
    - D. \(78 + n\)
11. Which situation best matches the expression $0.29x + 2$?

A) A taxi company charges a $2.00 flat fee plus $0.29 for every mile.
B) Jimmy ran 0.29 miles, stopped to rest, and then ran 2 more miles.
C) There are 0.29 grams of calcium in 2 servings of Hearty Health Cereal.
D) Amy bought 2 pieces of gum for $0.29 each.

12. Which of the following should be performed first to simplify this expression?

$16 \cdot 2 + (20 \div 5) - 3^2 \div 3 + 1$

A) $3^2 \div 3$
B) $20 \div 5$
C) $16 \cdot 2$
D) $3 + 1$

13. If $x = 15$ and $y = 5$, what is the value of $\frac{2x}{y} + 3y$?

14. What value of $r$ makes the following equation true?

$15r = 180$

15. An airplane has seats for 198 passengers. If each row seats 6 people, how many rows are on the plane?

16. What is the value of the expression $3^2 \times (2 + 3 \times 4) - 5$?

17. What is the solution to the equation $10 + s = 42$?

18. What is the sum of 4 and the product of 9 and 5?

19. Luke can swim 25 laps in one hour. Write an algebraic expression to show how many laps Luke can swim in $h$ hours. How many hours will it take Luke to swim 100 laps?

20. An aerobics instructor teaches a 45-minute class at 9:30 A.M., three times a week. She dedicates 12 minutes during each class to stretching. The rest of the class consists of aerobic dance. How many minutes of each class does the instructor spend teaching aerobic dance? Write and solve an equation to explain how you found your answer.

21. Ike and Joe ran the same distance but took different routes. Ike ran 3 blocks east and 7 blocks south. Joe ran 4 blocks west and then turned north. How far north did Joe run? Show your work.

22. The Raiders and the Hornets are buying new uniforms for their baseball teams. Each team member will receive a new cap, a jersey, and a pair of pants.

<table>
<thead>
<tr>
<th>Uniform Costs</th>
<th>Raiders</th>
<th>Hornets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap</td>
<td>$15</td>
<td>$15</td>
</tr>
<tr>
<td>Jersey</td>
<td>$75</td>
<td>$70</td>
</tr>
<tr>
<td>Pants</td>
<td>$60</td>
<td>$70</td>
</tr>
</tbody>
</table>

a. Let $r$ represent the number of Raiders team members, and let $h$ represent the number of Hornets team members. For each team, write an expression that gives the total cost of the team’s uniforms.

b. If the Raiders and the Hornets both have 12 team members, how much will each team spend on uniforms? Which team will spend the most, and by how much? Show your work.