Cosmologist

Dr. Stephen Hawking is a cosmologist. Cosmologists study the universe as a whole. They are interested in the origins, the structure, and the interaction of space and time.

The invention of the telescope has extended the vision of scientists far beyond nearby stars and planets. It has enabled them to view distant galaxies and structures that at one time were only theorized by astrophysicists such as Dr. Hawking. Astronomical distances are so great that we use scientific notation to represent them.

### Astronomical Distances

<table>
<thead>
<tr>
<th>Object</th>
<th>Distance from the Sun (km)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>$5.80 \times 10^7$</td>
</tr>
<tr>
<td>Venus</td>
<td>$1.082 \times 10^8$</td>
</tr>
<tr>
<td>Earth</td>
<td>$1.495 \times 10^8$</td>
</tr>
<tr>
<td>Mars</td>
<td>$2.279 \times 10^8$</td>
</tr>
<tr>
<td>Jupiter</td>
<td>$7.780 \times 10^8$</td>
</tr>
<tr>
<td>Saturn</td>
<td>$1.43 \times 10^9$</td>
</tr>
<tr>
<td>Uranus</td>
<td>$2.90 \times 10^9$</td>
</tr>
<tr>
<td>Neptune</td>
<td>$4.40 \times 10^9$</td>
</tr>
<tr>
<td>Pluto</td>
<td>$5.80 \times 10^9$</td>
</tr>
<tr>
<td>Nearest star</td>
<td>$3.973 \times 10^{13}$</td>
</tr>
</tbody>
</table>

*Distances of planets from the Sun are average distances.
**Vocabulary**

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

1. The operation that gives the quotient of two numbers is __?__.
2. The __?__ of the digit 3 in 4,903,672 is thousands.
3. The operation that gives the product of two numbers is __?__.
4. In the equation $15 \div 3 = 5$, the __?__ 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. 7,040,000  8. 4,556,890,100

**Use Repeated Multiplication**

Find each product.

13. $2 \cdot 2 \cdot 2$  14. $9 \cdot 9 \cdot 9 \cdot 9$
17. $3 \cdot 3 \cdot 5 \cdot 5$  18. $2 \cdot 2 \cdot 5 \cdot 7$

**Division Facts**

Find each quotient.

21. $49 \div 7$  22. $54 \div 9$  23. $96 \div 12$  24. $88 \div 8$
25. $42 \div 6$  26. $65 \div 5$  27. $39 \div 3$  28. $121 \div 11$

**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. 7 | 623  36. 24 | 149
Previously, you
• used order of operations to simplify whole number expressions without exponents.
• used multiplication and division to solve problems involving whole numbers.
• converted measures within the same measurement system.
• wrote large numbers in standard form.

In This Chapter
You will study
• simplifying numerical expressions involving order of operations and exponents.
• using concrete models to solve equations.
• finding solutions to application problems involving related measurement units.
• writing large numbers in scientific notation.

Vocabulary Connections
To become familiar with some of the vocabulary terms in the chapter, consider the following. You may refer to the chapter, the glossary, or a dictionary if you like.

1. The words equation, equal, and equator all begin with the Latin root equa-, meaning “level.” How can the Latin root word help you define equation?

2. The word numerical means “of numbers.” How might a numerical expression differ from an expression such as “the sum of two and five”?

3. When something is variable, it has the ability to change. In mathematics, a variable is an algebraic symbol. What special property do you think this type of symbol has?
**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 Helpful Hints, Reading Math notes, 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.

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**Try This**

Use your textbook for the following problems.

1. Use the index to find the page where *exponent* is defined.
2. In Lesson 1-9, what does the Remember box, located in the margin of page 43, remind you about the perimeter of a figure?
3. Use the glossary to find the definition of each term: *order of operations*, *numerical expression*, *equation*.
4. Where can you review how to multiply whole numbers?
Learn to identify and extend patterns.

Each year, football teams battle for the state championship. The table shows the number of teams in each round of a division's football playoffs. You can look for a pattern to find out how many teams are in rounds 5 and 6.

<table>
<thead>
<tr>
<th>Football Playoffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
</tr>
<tr>
<td>Number of Teams</td>
</tr>
</tbody>
</table>

Identifying and Extending Number Patterns

**Example 1**

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

**A** 64, 32, 16, 8, ____, ____, ____...

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

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

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

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

**B** 51, 44, 37, 30, ____, ____, ____...

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

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

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

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

**C** 2, 3, 5, 8, 12, ____, ____, ____...

\[
\begin{align*}
2 & \quad 3 & \quad 5 & \quad 8 & \quad 12 & \quad 17 & \quad 23 & \quad 30 \\
\end{align*}
\]

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

\[
\begin{align*}
12 + 5 &= 17 \\
17 + 6 &= 23 \\
23 + 7 &= 30 \\
\end{align*}
\]

The next three numbers will be 17, 23, and 30.
**EXAMPLE 2**

**Identifying and Extending Geometric Patterns**

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

A

![Image of squares, circles, and triangles]

The pattern is alternating squares and circles with triangles between them.

The next three figures will be ![next figures](image).

B

![Image of shaded triangles]

The pattern is to shade every other triangle in a clockwise direction.

The next three figures will be ![next figures with shading](image).

**EXAMPLE 3**

**Using Tables to Identify and Extend Patterns**

Make a table that shows the number of triangles in each figure. Then tell how many triangles are in the fifth figure of the 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>

The 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 $3, 6, \ldots$

2. **Tell** when it would be useful to make a table to help you identify and extend a pattern.
1-1 Exercises

GUIDED PRACTICE

1. Identify a possible pattern. Use the pattern to write the next three numbers.
   6, 14, 22, 30, , , ,...
2. 1, 3, 9, 27, , , ,...
3. 59, 50, 41, 32, , , ,...
4. 8, 9, 11, 14, , , ,...

5. Identify a possible pattern. Use the pattern to draw the next three figures.
   5. 6. 

7. Make a table that shows the number of green triangles in each figure. Then tell how many green triangles are in the fifth figure of the pattern. Use drawings to justify your answer.

8. 27, 24, 21, 18, , , ,...
9. 4,096, 1,024, 256, 64, , , ,...
10. 1, 3, 7, 13, 21, , , ,...

11. 14, 37, 60, 83, , , ,...

INDEPENDENT PRACTICE

1. Identify a possible pattern. Use the 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, , , ,...

2. Identify a possible pattern. Use the pattern to draw the next three figures.
   12. 13. 

3. Make a table that shows the number of dots in each figure. Then tell how many dots are in the sixth figure of the pattern. Use drawings to justify your answer.
   Figure 1 Figure 2 Figure 3 Figure 4

PRACTICE AND PROBLEM SOLVING

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. Critical Thinking Suppose the pattern 3, 6, 9, 12, 15 ... is continued forever. Will the number 100 appear in the pattern? Why or why not?
Identify a possible pattern. Use the pattern to find the missing numbers.

19. 3, 12, __, 192, 768, __, __, ...
20. 61, 55, __, 43, __, __, 25, __
21. __, __, 19, 27, 35, __, 51, __
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>

Draw the next three figures in each pattern.

24. ![Figure 1](1)
25. ![Figure 2](2)

26. **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.

```plaintext
3 5 8 10 13 15
```

27. **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.

28. **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.

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

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**Test Prep and Spiral Review**

30. **Multiple Choice** Which is the missing number in the pattern 2, 6, __, 54, 162, ...

   - A 10
   - B 18
   - C 30
   - D 48

31. **Gridded Response** Find the next number in the pattern 9, 11, 15, 21, 29, 39, ...

Round each number to the nearest ten. *(Previous course)*

32. 61
33. 88
34. 105
35. 2,019
36. 11,403

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

37. 91
38. 543
39. 952
40. 4,050
41. 23,093
Learn to represent numbers by using exponents.

**Vocabulary**
- power
- exponent
- base

A DNA molecule makes a copy of itself by splitting in half. Each half becomes a molecule 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 $2 \cdot 2 \cdot 2 \cdot 2 = 16$.

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.

**Reading Math**
Read $2^4$ as “the fourth power of 2” or “2 to the fourth power.”

**Example 1** Evaluating Powers

Find each value.

- **A** $5^2$
  
  $5^2 = 5 \cdot 5$
  
  $= 25$

- **B** $2^6$
  
  $2^6 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$
  
  $= 64$

- **C** $25^1$  
  
  $25^1 = 25$

Any number to the zero power, except zero, is equal to 1.

$6^0 = 1$  
$10^0 = 1$  
$19^0 = 1$

Zero to the zero power is **undefined**, meaning that it does not exist.
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

\[
49 = 7 \cdot 7 = 7^2
\]

7 is used as a factor 2 times.

**B.** 81, base 3

\[
81 = 3 \cdot 3 \cdot 3 \cdot 3 = 3^4
\]

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?

<table>
<thead>
<tr>
<th>Earthquake Strength</th>
<th>Category</th>
<th>Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Major</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Great</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

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.
1-2 Exercises

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, base 5  
7. 16, base 4  
8. 27, base 3  
9. 100, base 10

See Example 3
10. 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. \(2^5\)  
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, base 9  
22. 4, base 4  
23. 64, base 4  
24. 1, base 7  
25. 32, base 2  
26. 128, base 2  
27. 1,600, base 40  
28. 2,500, base 50  
29. 100,000, 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

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

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. Patterns 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. Life Science A newborn panda cub weighs an average of 4 ounces. How many ounces might a one-year-old panda weigh if its weight increases by the power of 5 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** Explain why $6^3 \neq 3^6$.

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

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

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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?

   - F. $6^4$
   - G. $4^3$
   - H. $2^6$
   - I. $8^2$

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

Simplify. *(Previous course)*

63. $15 + 27 + 5 + 3 + 11 + 16 + 7 + 4$  
64. $2 + 6 + 5 + 7 + 100 + 1 + 75$

65. $2 + 9 + 8 + 12 + 6 + 8 + 5 + 6 + 7$  
66. $9 + 30 + 4 + 1 + 4 + 1 + 7 + 5$

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

67. 100, 91, 82, 73, 64, . . .  
68. 17, 19, 22, 26, 31, . . .  
69. 2, 6, 18, 54, 162, . . .
Learn to identify, convert, and compare metric units.

The Micro Flying Robot II is the world's lightest helicopter. Produced in Japan in 2004, the robot is 85 millimeters tall and has a mass of 8.6 grams.

You can use the following benchmarks to help you understand millimeters, grams, and other metric units.

### Choosing the Appropriate Metric Unit

Choose the most appropriate metric unit for each measurement. Justify your answer.

**A** The length of a car
   Meters—the length of a car is similar to the width of several doorways.

**B** The mass of a skateboard
   Kilograms—the mass of a skateboard is similar to the mass of several textbooks.

**C** The recommended dose of a cough syrup
   Milliliters—one dose of cough syrup is similar to the amount of liquid in several eyedroppers.
The prefixes of metric units correlate to place values in the base-10 number system. The table shows how metric units are based on powers of 10.

<table>
<thead>
<tr>
<th>Prefixes: Metric Units</th>
<th>Multiples of Base-10</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milli-</td>
<td>(10^{-3})</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Centi-</td>
<td>(10^{-2})</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Kilo-</td>
<td>(10^{3})</td>
<td>(1,000)</td>
</tr>
</tbody>
</table>

You can convert units within the metric system by multiplying or dividing by powers of 10. To convert to a smaller unit, you must multiply. To convert to a larger unit, you must divide.

**Converting Metric Units**

Convert each measure.

A. 510 cm to meters

\[510 \text{ cm} = (510 \div 100) \text{ m} = 5.1 \text{ m}\]

Move the decimal point 2 places left: 510.

B. 2.3 L to milliliters

\[2.3 \text{ L} = (2.3 \times 1,000) \text{ mL} = 2,300 \text{ mL}\]

Move the decimal point 3 places right: 2,300.

**Using Unit Conversion to Make Comparisons**

Mai and Brian are measuring the mass of rocks in their earth science class. Mai's rock has a mass of 480 g. Brian's rock has a mass of 0.05 kg. Whose rock has the greater mass?

You can convert the mass of Mai's rock to kilograms.

\[480 \text{ g} = (480 \div 1,000) \text{ kg} = 0.48 \text{ kg}\]

Since 0.48 kg > 0.05 kg, Mai's rock has the greater mass.

**Check**

Use number sense. There are 1,000 grams in a kilogram, so the mass of Mai's rock is about half a kilogram, or 0.5 kg. This is much greater than 0.05 kg, the mass of Brian's rock, so the answer is reasonable.

**Think and Discuss**

1. **Tell** how the metric system relates to the base-10 number system.
2. **Explain** why it makes sense to multiply when you convert to a smaller unit.
1-3 Exercises

**GUIDED PRACTICE**

See Example 1
Choose the most appropriate metric unit for each measurement.
Justify your answer.

1. The mass of a pumpkin
2. The amount of water in a pond
3. The length of an eagle’s beak
4. The mass of a penny

See Example 2
Convert each measure.

5. 12 kg to grams
6. 4.3 m to centimeters
7. 0.7 mm to centimeters
8. 3,200 mL to liters

See Example 3
9. On Sunday, Li ran 0.8 km. On Monday, she ran 7,200 m. On which day did Li run farther? Use estimation to explain why your answer makes sense.

**INDEPENDENT PRACTICE**

See Example 1
Choose the most appropriate metric unit for each measurement.
Justify your answer.

10. The capacity of a teacup
11. The mass of 10 grains of salt
12. The height of a palm tree
13. The distance between your eyes

See Example 2
Convert each measure.

14. 0.067 L to milliliters
15. 1.4 m to kilometers
16. 900 mg to grams
17. 355 cm to millimeters

See Example 3
18. Carmen pours 75 mL of water into a beaker. Nick pours 0.75 L of water into a different beaker. Who has the greater amount of water? Use estimation to explain why your answer makes sense.

**PRACTICE AND PROBLEM SOLVING**

Convert each measure.

19. 1.995 m = \_ cm
20. 0.0004 kg = \_ g
21. 2,050 kL = \_ L
22. 0.002 mL = \_ L
23. 3.7 mm = \_ cm
24. 61.8 g = \_ mg

Compare. Write <,>, or =.

25. 0.1 cm \_ 1 mm
26. 25 g \_ 3,000 mg
27. 340 mg \_ 0.4 g
28. 0.05 kL \_ 5 L
29. 0.3 mL \_ 0.005 L
30. 1.3 kg \_ 1,300 g
31. Art The Mona Lisa by Leonardo da Vinci is 77 cm tall. Starry Night by Vincent Van Gogh is 0.73 m tall. Which is the taller painting? How much taller is it?
Write each set of measures in order from least to greatest.

32. 0.005 kL; 4.1 L; 6,300 mL
33. 1.5 m; 1,200 mm; 130 cm
34. 4,000 mg; 50 kg; 70 g
35. 9.03 g; 0.0008 kg; 1,000 mg

36. **Measurement** Use a ruler to measure the line segment at right in centimeters. Then give the length of the segment in millimeters and meters.

**Life Science** The table gives information about several species of Vesper, or Evening, bats. Use the table for Exercises 37 and 38.

<table>
<thead>
<tr>
<th>Name</th>
<th>Wingspread</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Bat</td>
<td>0.3 m</td>
<td>10.9 g</td>
</tr>
<tr>
<td>Silver-Haired Bat</td>
<td>28.7 cm</td>
<td>8,500 mg</td>
</tr>
<tr>
<td>Big Brown Bat</td>
<td>317 mm</td>
<td>0.01 kg</td>
</tr>
</tbody>
</table>

37. Which bat has the greatest mass?

38. Which bat has a longer wingspread, the Red Bat or the Big Brown Bat? How much longer is its wingspread?

39. **Critical Thinking** One milliliter of water has a mass of 1 gram. What is the mass of a liter of water?

40. **What's the Error?** A student converted 45 grams to milligrams as shown below. Explain the student’s error.
   
   $$45 \text{ g} = (45 \div 1,000) \text{ mg} = 0.045 \text{ mg}$$

41. **Write About It** Explain how to decide whether milligrams, grams, or kilograms are the most appropriate unit for measuring the mass of an object.

42. **Challenge** A decimeter is \(\frac{1}{10}\) of a meter. Explain how to convert millimeters to decimeters.

**43. Multiple Choice** Which of these is the same as 0.4 grams?

- A 0.0004 mg
- B 0.004 mg
- C 400 mg
- D 4,000 mg

44. **Short Response** Which has a greater capacity, a measuring cup that holds 250 mL or a measuring cup that holds 0.5 L? Justify your answer.

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

45. 19, 16, 13, 10, , , ,
46. 5, 15, 45, 135, , , ,
47. 5, 6, 8, 11, 15, , , ,
48. 256, 128, 64, 32, , , ,

Find each value. (Lesson 1-2)

49. \(9^2\)
50. \(12^1\)
51. \(2^7\)
52. \(7^3\)
53. \(3^4\)
The distance from Venus to the Sun is greater than 100,000,000 kilometers. You can write this number as a power of ten by using a base of ten and an exponent.

\[
10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 = 10^8
\]

The table shows several powers of ten.

<table>
<thead>
<tr>
<th>Power of 10</th>
<th>Meaning</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10^1)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>(10^2)</td>
<td>10 \cdot 10</td>
<td>100</td>
</tr>
<tr>
<td>(10^3)</td>
<td>10 \cdot 10 \cdot 10</td>
<td>1,000</td>
</tr>
<tr>
<td>(10^4)</td>
<td>10 \cdot 10 \cdot 10 \cdot 10</td>
<td>10,000</td>
</tr>
</tbody>
</table>

You can find the product of a number and a power of ten by multiplying or by moving the decimal point of the number. For powers of ten with positive exponents, move the decimal point to the right.

**EXAMPLE 1**

**Multiplying by Powers of Ten**

Multiply \(137 \cdot 10^3\).

**Method 1:** Evaluate the power.

\[
137 \cdot 10^3 = 137 \cdot (10 \cdot 10 \cdot 10)
\]

\[
= 137 \cdot 1,000
\]

\[
= 137,000
\]

**Method 2:** Use mental math.

\[
137 \cdot 10^3 = 137,000
\]

\[
= 137,000
\]

A factor is a number that is multiplied by another number to get a product. **Scientific notation** is a kind of shorthand that can be used to write large numbers. Numbers expressed in scientific notation are written as the product of two factors.
In scientific notation, 17,900,000 is written as

\[ 1.79 \times 10^7 \]

**Writing Numbers in Scientific Notation**

Write 9,580,000 in scientific notation.

\[ 9,580,000 = 9,580,000. \]

\[ = 9.58 \times 10^6 \]

**Writing Numbers in Standard Form**

Pluto is about \( 3.7 \times 10^9 \) miles from the Sun. Write this distance in standard form.

\[ 3.7 \times 10^9 = 3,700,000,000 \]

Pluto is about 3,700,000,000 miles from the Sun.

**Comparing Numbers in Scientific Notation**

Mercury is \( 9.17 \times 10^7 \) kilometers from Earth. Jupiter is \( 6.287 \times 10^8 \) kilometers from Earth. Which planet is closer to Earth?

To compare numbers written in scientific notation, first compare the exponents. If the exponents are equal, then compare the decimal portion of the numbers.

Mercury: \( 9.17 \times 10^7 \) km

Jupiter: \( 6.287 \times 10^8 \) km

Notice that \( 7 < 8 \). So \( 9.17 \times 10^7 < 6.287 \times 10^8 \).

Mercury is closer to Earth than Jupiter.

**Think and Discuss**

1. **Tell** whether \( 15 \times 10^9 \) is in scientific notation. Explain.
2. **Compare** \( 4 \times 10^3 \) and \( 3 \times 10^4 \). Explain how you know which is greater.
1-4 Exercises

GUIDED PRACTICE

See Example 1
Multiply.
1. \(15 \cdot 10^2\)  2. \(12 \cdot 10^4\)  3. \(208 \cdot 10^3\)  4. \(113 \cdot 10^7\)

See Example 2
Write each number in scientific notation.
5. \(3,600,000\)  6. \(214,000\)  7. \(8,000,000,000\)  8. \(42,000\)

See Example 3
9. A drop of water contains about \(2.0 \times 10^{21}\) molecules. Write this number in standard form.

See Example 4
10. Astronomy The diameter of Neptune is \(4.9528 \times 10^7\) meters. The diameter of Mars is \(6.7868 \times 10^6\) meters. Which planet has the larger diameter?

INDEPENDENT PRACTICE

See Example 1
Multiply.
11. \(21 \cdot 10^2\)  12. \(8 \cdot 10^4\)  13. \(25 \cdot 10^5\)  14. \(40 \cdot 10^4\)
15. \(268 \cdot 10^3\)  16. \(550 \cdot 10^7\)  17. \(2,115 \cdot 10^5\)  18. \(70,030 \cdot 10^1\)

See Example 2
Write each number in scientific notation.
19. \(428,000\)  20. \(1,610,000\)  21. \(3,000,000,000\)  22. \(60,100\)
23. \(52,000\)  24. \(29.8 \cdot 10^7\)  25. \(8,900,000\)  26. \(500 \cdot 10^3\)

See Example 3
27. History Ancient Egyptians hammered gold into sheets so thin that it took \(3.67 \times 10^5\) sheets to make a pile 2.5 centimeters high. Write the number of sheets in standard form.

See Example 4
28. Astronomy Mars is \(7.83 \times 10^7\) kilometers from Earth. Venus is \(4.14 \times 10^7\) kilometers from Earth. Which planet is closer to Earth?

PRACTICE AND PROBLEM SOLVING

Find the missing number or numbers.
29. \(24,500 = 2.45 \times 10^n\)  30. \(16,800 = \square \times 10^n\)  31. \(\square = 3.40 \times 10^2\)
32. \(280,000 = 2.8 \times 10^n\)  33. \(5.4 \times 10^8 = \square\)
34. \(60,000,000 = \square \times 10^n\)

Tell whether each number is written in scientific notation. Then order the numbers from least to greatest.
35. \(43.7 \times 10^6\)  36. \(1 \times 10^7\)  37. \(2.9 \times 10^7\)  38. \(305 \times 10^6\)
39. Physical Science In a vacuum, light travels at a speed of about nine hundred and eighty million feet per second. Write this speed in scientific notation.
40. The earliest rocks native to Earth formed during the Archean eon. Calculate the length of this eon. Write your answer in scientific notation.

41. Dinosaurs lived during the Mesozoic era. Calculate the length of the Mesozoic era. Write your answer in scientific notation.

42. Tropites were prehistoric marine animals whose fossil remains can be used to date the rock formations in which they are found. Such fossils are known as index fossils. Tropites lived between $2.08 \times 10^8$ and $2.30 \times 10^8$ years ago. During what geologic time period did they live?

43. **Write About It** Explain why scientific notation is especially useful in earth science.

44. **Challenge** We live in the Holocene epoch. Write the age of this epoch in scientific notation.

---

**Test Prep and Spiral Review**

45. **Multiple Choice** Kaylee wrote in her dinosaur report that the Jurassic period was $1.75 \times 10^8$ years ago. According to Kaylee’s report, how many years ago was the Jurassic period?

   A. 1,750,000  
   B. 17,500,000  
   C. 175,000,000  
   D. 17,500,000,000

46. **Multiple Choice** What is 2,430,000 in scientific notation?

   F. $243 \times 10^4$  
   G. $2.43 \times 10^5$  
   H. $2.43 \times 10^5$  
   J. $2.43 \times 10^6$

Write each number using an exponent and the given base. (Lesson 1-2)

47. 625, base 5  
48. 512, base 8  
49. 512, base 2

Convert each measure. (Lesson 1-3)

50. 2.87 kg to grams  
51. 1,700 m to kilometers  
52. 8 L to milliliters
Scientists often have to work with very large numbers. For example, the Andromeda Galaxy contains over 200,000,000,000 stars. Scientific notation is a compact way of expressing large numbers such as this.

**Activity**

1. Show 200,000,000,000 in scientific notation.
   
Enter 200,000,000,000 on your graphing calculator. Then press 2
   11 on the calculator display means $2 \times 10^{11}$, which is 200,000,000,000 in scientific notation. Your calculator automatically puts very large numbers into scientific notation.

   You can use the EE function to enter $2 \times 10^{11}$ directly into the calculator. Enter $2 \times 10^{11}$ by pressing 2 2nd E E 11 1.

2. Simplify $2.31 \times 10^4 \div 525$.

   Enter $2.31 \times 10^4$ into your calculator in scientific notation, and then divide by 525. To do this, press 2.31 2nd E E key 4 4 ÷ 525 ENTER. Your answer should be 44.

**Think and Discuss**

1. Explain how scientific notation and calculator notation are similar. What could the “E” possibly stand for in calculator notation?

**Try This**

Use the calculator to write each number in scientific notation.

1. 6,500,000
2. 15,000,000
3. 360,000,000,000

Simplify each expression, and express your answer in scientific notation.

4. $8.4 \times 10^6 \div 300$
5. $9 \times 10^3 - 900$
6. $2.5 \times 10^9 \times 10$
7. $3 \times 10^2 + 6000$
8. $2.85 \times 10^8 \div 95$
9. $1.5 \times 10^7 + 150$
Learn to use the order of operations to simplify numerical expressions.

**Vocabulary**

- Numerical expression
- Order of operations

**Example 1**

Using the Order of Operations

Simplify each expression.

A. \[27 - 18 \div 6\]
   - \[27 - 18 \div 6\] Divide.
   - \[27 - 3\] Subtract.
   - 24

B. \[36 - 18 \div 2 \cdot 3 + 8\]
   - \[36 - 18 \div 2 \cdot 3 + 8\] Divide and multiply from left to right.
   - \[36 - 9 \cdot 3 + 8\]
   - \[36 - 27 + 8\] Subtract and add from left to right.
   - 9 + 8
   - 17

C. \[5 + 6^2 \cdot 10\]
   - \[5 + 6^2 \cdot 10\] Evaluate the power.
   - \[5 + 36 \cdot 10\] Multiply.
   - \[5 + 360\] Add.
   - 365

**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.
Using the Order of Operations with Grouping Symbols

Simplify each expression.

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

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

Perform the operation in parentheses.

\[36 - 12 \div 3\]

Divide.

\[36 - 4\]

Subtract.

\[32\]

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

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

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

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

\[7 - 2]^3\]

\[5^3\]

\[125\]

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.

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

Perform the operations in parentheses.

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

Add.

\[21 \cdot 20\]

Multiply.

\[420\]

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.
1-5 Order of Operations

GUIDED PRACTICE

Simplify each expression.
1. \(43 + 16 ÷ 4\) 2. \(28 - 4 ÷ 3 + 6 + 4\) 3. \(25 - 4^2 ÷ 8\)

Simplify each expression.
4. \(26 - (7 ÷ 3) + 2\) 5. \((3^2 + 11) ÷ 5\) 6. \(32 + 6(4 - 2^2) + 8\)

See Example
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 \((3 \cdot 4 + 2 \cdot 8) \cdot 10\) to find out how much Caleb earned in all.

INDEPENDENT PRACTICE

Simplify each expression.
8. \(3 + 7 \cdot 5 - 1\) 9. \(5 \cdot 9 - 3\) 10. \(3 - 2 + 6 \cdot 2^2\)

Simplify each expression.
11. \((3 - 3)^2 ÷ 3 + 3\) 12. \(2^5 - (4 \cdot 5 + 3)\) 13. \((3 ÷ 3) + 3 \cdot (3^3 - 3)\)

Simplify each expression.
14. \(4^3 ÷ 8 - 2\) 15. \((8 - 2)^2 \cdot (8 - 1)^2 ÷ 3\) 16. \(9,234 ÷ [3 \cdot 3(1 + 8^3)]\)

See Example
17. **Consumer Math** Maki paid a $14 basic fee plus $25 a day to rent a car. Simplify the expression \(14 + 5 \cdot 25\) 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 \(35 + 20(12^2 ÷ 9)\) to find out how much Enrico spent to carpet a 12 ft by 12 ft room.

PRACTICE AND PROBLEM SOLVING

Simplify each expression.
19. \(90 - 36 \times 2\) 20. \(16 + 14 ÷ 2 - 7\) 21. \(64 ÷ 2^2 + 4\)

22. \(10 \times (18 - 2) + 7\) 23. \((9 - 4)^2 - 12 \times 2\) 24. \([1 + (2 + 5)^2] \times 2\)

Compare. Write \(<\), \(>\), or \(=\).
25. \(8 \cdot 3 - 2\) \(\square\) \(8 \cdot (3 - 2)\) 26. \((6 + 10) ÷ 2\) \(\square\) \(6 + 10 ÷ 2\)
27. \(12 ÷ 3 \cdot 4\) \(\square\) \(12 ÷ (3 \cdot 4)\) 28. \(18 + 6 - 2\) \(\square\) \(18 + (6 - 2)\)
29. \([6(8 - 3) + 2]\) \(\square\) \(6(8 - 3) + 2\) 30. \((18 - 14) ÷ (2 + 2)\) \(\square\) \(18 - 14 ÷ 2 + 2\)

**Critical Thinking** Insert grouping symbols to make each statement true.
31. \(4 \cdot 8 - 3 = 20\) 32. \(5 + 9 - 3 ÷ 2 = 8\) 33. \(12 - 2^2 ÷ 5 = 20\)

34. \(4 \cdot 2 + 6 = 32\) 35. \(4 + 6 - 3 ÷ 7 = 1\) 36. \(9 \cdot 8 - 6 ÷ 3 = 6\)

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 \(8 \cdot 4 + 10 \cdot 5\) 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 \((512 \cdot 4 - 512) ÷ 2\) 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 evaluate 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 \(((2 + 4)^2 - 2 \cdot 3) ÷ 6\).

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.

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**Test Prep and Spiral Review**

### 43. **Multiple Choice** Which operation should be performed first to simplify the expression \(18 - 1 \cdot 9 ÷ 3 + 8\)?

- **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** \(2 \cdot 30 + 3 \cdot 5\)

**Find each value. (Lesson 1-2)**

46. \(8^6\)  
47. \(9^3\)  
48. \(4^5\)  
49. \(3^3\)  
50. \(7^1\)

**Multiply. (Lesson 1-4)**

51. \(612 \cdot 10^3\)  
52. \(43.8 \cdot 10^6\)  
53. \(590 \cdot 10^5\)  
54. \(3.1 \cdot 10^7\)  
55. \(1.91 \cdot 10^2\)
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.

Many calculators have an $x^2$ 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, $\wedge$. For example, to evaluate $3^5$, press $3 \ w^5 \ 5$, and then press $\text{Enter}$.

Activity

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

   First simplify the expression using paper and pencil:
   
   $4 \cdot 2^3 = 4 \cdot 8 = 32$.

   Then simplify $4 \cdot 2^3$ using your calculator.

   Notice that the calculator automatically evaluates the power first. If you want to perform the multiplication first, you must put that operation inside parentheses.

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

6. $(2.1 + 5.6 \cdot 4^3) ÷ 6^4$
7. $[(2.1 + 5.6) \cdot 4^3] ÷ 6^4$
8. $[(8.6 - 1.5) ÷ 2^3] + 5^2$
In Lesson 1-5 you learned how to use the order of operations to simplify numerical expressions. The following properties of rational numbers are also useful when you simplify expressions.

### Vocabulary
- **Commutative Property**
- **Associative Property**
- **Identity Property**
- **Distributive Property**

#### Example 1
**Identifying Properties of Addition and Multiplication**

Tell which property is represented.

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

B. $25 \cdot 1 = 25$
   
   $25 \cdot 1 = 25$  \textit{One of the factors is 1.}
   
   Identity Property

C. $xy = yx$
   
   $xy = yx$  \textit{The order of the variables is switched.}
   
   Commutative Property
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. \(12 + 19 + 18\)

\[
\begin{align*}
12 + 19 + 18 &= 19 + 12 + 18 & \text{Commutative Property} \\
&= 19 + (12 + 18) & \text{Associative Property} \\
&= 19 + 30 & \text{Add.} \\
&= 49
\end{align*}
\]

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

\[
\begin{align*}
25 \cdot 13 \cdot 4 &= 25 \cdot 4 \cdot 13 & \text{Commutative Property} \\
&= (25 \cdot 4) \cdot 13 & \text{Associative Property} \\
&= 100 \cdot 13 & \text{Multiply.} \\
&= 1,300
\end{align*}
\]

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.

<table>
<thead>
<tr>
<th>Distributive Property</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Numbers</strong></td>
</tr>
<tr>
<td><strong>Algebra</strong></td>
</tr>
</tbody>
</table>

**Example 3: Using the Distributive Property to Multiply Mentally**

Use the Distributive Property to find 7(29).

Method 1

\[
\begin{align*}
7(29) &= 7(20 + 9) & \text{Rewrite 29.} \\
&= (7 \cdot 20) + (7 \cdot 9) & \text{Use the Distributive Property.} \\
&= 140 + 63 & \text{Multiply.} \\
&= 203 & \text{Simplify.}
\end{align*}
\]

Method 2

\[
\begin{align*}
7(29) &= 7(30 - 1) \\
&= (7 \cdot 30) - (7 \cdot 1) \\
&= 210 - 7 \\
&= 203
\end{align*}
\]

**Think and Discuss**

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

2. **Explain** how the Distributive Property can help you find 6 \(\cdot 102\) using mental math.
GUIDED PRACTICE

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. $x + y = y + x$

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. $5 \cdot 19 \cdot 20$

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

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. $16 \cdot 4 = 4 \cdot 16$

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. $25 + 17 + 75$

Use the Distributive Property to find each product.

31. $9(15)$
32. $(14)5$
33. $(58)3$
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. \(5 + 16 = 16 + \square\)  
47. \(15 \cdot 1 = \square\)  
48. \(\square \cdot (4 + 7) = 3 \cdot 4 + 3 \cdot 7\)  
49. \(20 + \square = 20\)  
50. \(2 \cdot \square \cdot 9 = (2 \cdot 13) \cdot 9\)  
51. \(8 + (\square + 4) = (8 + 8) + 4\)  
52. \(2 \cdot (6 + 1) = 2 \cdot \square + 2 \cdot 1\)  
53. \((12 - 9) \cdot \square = 12 \cdot 2 - 9 \cdot 2\)

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 Subtraction? Give an example to justify your answer.

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

---

**Test Prep and Spiral Review**

58. **Multiple Choice** Which is an example of the Associative Property?

- A. \(4 + 0 = 4\)
- B. \(9 + 8 + 2 = 9 + (8 + 2)\)
- C. \(5 + 7 = 7 + 5\)
- D. \(5 \cdot (12 + 3) = 5 \cdot 12 + 5 \cdot 3\)

59. **Multiple Choice** Which property is \(2 \cdot (3 + 7) = (2 \cdot 3) + (2 \cdot 7)\) an example of?

- F. Associative  
- G. Commutative  
- H. Distributive  
- I. Identity

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

Write each number using an exponent and the given base. (Lesson 1-2)

- 61. \(36\), base 6  
- 62. \(64\), base 2  
- 63. \(9\), base 3  
- 64. \(1,000\), base 10

Simplify each expression. (Lesson 1-5)

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

---

1-6 Properties 31
Quiz for Lessons 1-1 Through 1-6

1-1 Numbers and Patterns

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

1. 8, 15, 22, 29, . . .
2. 79, 66, 53, 40, . . .
3. [Patterns not shown]

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 Metric Measurements

Convert each measure.

9. 17.3 kg to grams
10. 540 mL to liters
11. 0.46 cm to millimeters
12. Cat ran in the 400-meter dash and the 800-meter run. Hilo ran in the 2-kilometer cross-country race. All together, who ran the farthest, Cat or Hilo?

1-4 Applying Exponents

Multiply.

13. $456 \cdot 10^5$
14. $9.3 \cdot 10^2$
15. $0.36 \cdot 10^8$

Write each number in scientific notation.

16. 8,400,000
17. 521,000,000
18. 29,000

19. In May 2005, the world’s population was over 6,446,000,000 and was increasing by 140 people each minute! Write this population in scientific notation.

1-5 Order of Operations

Simplify each expression.

20. $8 - 14 \div (9 - 2)$
21. $54 - 6 \cdot 3 + 4^2$
22. $4 - 24 \div 2^3$
23. $(3 + 2)^2 - 9$

1-6 Properties

Simplify each expression. Justify each step.

24. $29 + 50 + 21$
25. $5 \cdot 18 \cdot 20$
26. $34 + 62 + 36$
27. $3 \cdot 11 \cdot 20$

Chapter 1 Algebraic Reasoning
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, 7 quartets from different schools competed. How many students competed in the quartet competition?
Learn to evaluate algebraic expressions.

Vocabulary

variable
constant
algebraic expression
evaluate

Ron Howard was born in 1954. You can find out what year Ron turned 16 by adding 16 to the year he was born.

\[ 1954 + 16 \]

In algebra, letters are often used to represent numbers. You can use a letter such as \( a \) to represent Ron Howard’s age. When he turns \( a \) years old, the year will be

\[ 1954 + a. \]

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 consists of one or more variables. It usually contains constants and operations. For example, \( 1954 + a \) is an algebraic expression for the year Ron Howard turns a certain age.

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

**EXAMPLE 1**

Evaluate \( n + 7 \) for each value of \( n \).

\[
\begin{align*}
\text{A } n & = 3 & & n + 7 \\
& & 3 + 7 & \text{Substitute 3 for } n. \\
& & & 10 & \text{Add.}
\end{align*}
\]

\[
\begin{align*}
\text{B } n & = 5 & & n + 7 \\
& & 5 + 7 & \text{Substitute 5 for } n. \\
& & & 12 & \text{Add.}
\end{align*}
\]
Multiplication and division of variables can be written in several ways, as shown in the table.

When evaluating expressions, use the order of operations.

### Evaluating Algebraic Expressions Involving Order of Operations

Evaluate each expression for the given value of the variable.

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

\[
\begin{align*}
3(5) - 2 & \quad \text{Substitute 5 for } x. \\
15 - 2 & \quad \text{Multiply.} \\
13 & \quad \text{Subtract}
\end{align*}
\]

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

\[
\begin{align*}
4 \div 2 + 4 & \quad \text{Substitute 4 for } n. \\
2 + 4 & \quad \text{Divide.} \\
6 & \quad \text{Add}
\end{align*}
\]

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

\[
\begin{align*}
6(2)^2 + 2(2) & \quad \text{Substitute 2 for } y. \\
6(4) + 2(2) & \quad \text{Evaluate the power.} \\
24 + 4 & \quad \text{Multiply.} \\
28 & \quad \text{Add}
\end{align*}
\]

### Evaluating Algebraic Expressions with Two Variables

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

\[
\begin{align*}
\frac{3}{n} + 2m & \\
\frac{3}{3} + 2(4) & \quad \text{Substitute 3 for } n \text{ and } 4 \text{ for } m. \\
1 + 8 & \quad \text{Divide and multiply from left to right.} \\
9 & \quad \text{Add}
\end{align*}
\]

### 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.
Exercises

1. Evaluate \( n + 9 \) for each value of \( n \).
   1. \( n = 3 \)  
   2. \( n = 2 \)  
   3. \( n = 11 \)

2. Evaluate each expression for the given value of the variable.
   4. \( 2x - 3 \) for \( x = 4 \)
   5. \( n + 3 + n \) for \( n = 6 \)
   6. \( 5y^2 + 3y \) for \( y = 2 \)

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

1. Evaluate \( n + 5 \) for each value of \( n \).
   9. \( n = 17 \)  
   10. \( n = 9 \)  
   11. \( n = 0 \)

2. Evaluate each expression for the given value of the variable.
   12. \( 5y - 1 \) for \( y = 3 \)
   13. \( 10b - 9 \) for \( b = 2 \)
   14. \( p / 7 + p \) for \( p = 14 \)
   15. \( n + 5 + n \) for \( n = 20 \)
   16. \( 3x^2 + 2x \) for \( x = 10 \)
   17. \( 3c^2 - 5c \) for \( c = 3 \)

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. \( 9 - \frac{3x}{4} + 20y \) for \( x = 4 \) and \( y = 5 \)
   21. \( r^2 + 15k \) for \( r = 15 \) and \( k = 5 \)

PRACTICE AND PROBLEM SOLVING

Evaluate each expression for the given values of the variables.

22. \( 20x - 10 \) for \( x = 4 \)
23. \( 4d^2 - 3d \) for \( d = 2 \)
24. \( 22p + 11 + p \) for \( p = 3 \)
25. \( q + q^2 + q + 2 \) for \( q = 4 \)
26. \( \frac{16}{k} + 7h \) for \( k = 8 \) and \( h = 2 \)
27. \( f + 3 + f \) for \( f = 18 \)
28. \( 3t + 3 + t \) for \( t = 13 \)
29. \( 9 + 3p - 5t + 3 \) for \( p = 2 \) and \( t = 1 \)
30. \( 108 - 12j + j \) for \( j = 9 \)
31. \( 3m^3 + \frac{y}{5} \) for \( m = 2 \) and \( y = 35 \)

32. The expression \( 60m \) gives the number of seconds in \( m \) minutes. Evaluate \( 60m \) for \( m = 7 \). How many seconds are there in 7 minutes?

33. **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?

34. **Physical Science** A color TV has a power rating of 200 watts. The expression \( 200t \) gives the power used by \( t \) color TV sets. Evaluate \( 200t \) for \( t = 13 \). How much power is used by 13 TV sets?
35. **Physical Science** The expression $1.8c + 32$ can be used to convert a temperature in degrees Celsius $c$ to degrees Fahrenheit. What is the temperature in degrees Fahrenheit if the temperature is $30°C$?

36. **Physical 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.

37. **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?

38. **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.

39. **Challenge** Evaluate the expression $\frac{x+y}{y-x}$ for $x = 6$ and $y = 8$.

40. **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 $t = 25$

41. **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.
   
   F. $132$
   G. $140$
   H. $164$
   I. $176$

   Write each number in scientific notation. *(Lesson 1-4)*
   42. 102.45
   43. 62,100,000
   44. 769,000
   45. 800,000

   Use the Distributive Property to find each product. *(Lesson 1-6)*
   46. $5(16)$
   47. $(17)4$
   48. $7(23)$
   49. $(29)3$
Learn to translate words into numbers, variables, and operations.

Although they are closely related, 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.

### Example 1
**Translating Verbal Expressions into Algebraic Expressions**

Write each phrase as an algebraic expression.

- **A** the product of 20 and $t$
  
  **B** 24 less than a number

  **product** means “multiply”
  
  **less than** means “subtract from”

  $20t$

  $n - 24$
Write each phrase as an algebraic expression.

C 4 times the sum of a number and 2

\[ 4 \times \text{the sum of a number and 2} = 4(n + 2) \]

D the sum of 4 times a number and 2

\[ \text{the sum of 4 times a number and 2} = 4n + 2 \]

When solving real-world problems, you may need to determine the action to know which operation to use.

<table>
<thead>
<tr>
<th>Action</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Put parts together</td>
<td>Add</td>
</tr>
<tr>
<td>Put equal parts together</td>
<td>Multiply</td>
</tr>
<tr>
<td>Find how much more or less</td>
<td>Subtract</td>
</tr>
<tr>
<td>Separate into equal parts</td>
<td>Divide</td>
</tr>
</tbody>
</table>

**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.

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

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

B To rent a certain car for a day costs $84 plus $0.29 for every mile the car is driven. Write an algebraic expression to show how much it costs to rent the car for a day.

The cost includes $0.29 per mile. Use \( m \) for the number of miles.

Multiply to put equal parts together: \( 0.29m \)

In addition to the fee per mile, the cost includes a flat fee of $84.

Add to put parts together: \( 84 + 0.29m \)

**Think and Discuss**

1. **Write** three different verbal expressions that can be represented by \( 2 - y \).

2. **Explain** how you would determine which operation to use to find the number of chairs in 6 rows of 100 chairs each.
1-8 Exercises

GUIDED PRACTICE

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. Carly spends $5 for \( n \) notebooks. Write an algebraic expression to represent the cost of one notebook.

6. A company charges $46 for cable TV installation and $21 per month for basic cable service. Write an algebraic expression to represent the total cost of \( m \) months of basic cable service, including installation.

INDEPENDENT PRACTICE

Write each phrase as an algebraic expression.

7. the sum of 5 and a number

8. 2 less than a number

9. the quotient of a number and 8

10. 9 times a number

11. 10 less than the product of a number and 3

12. Video Express sells used tapes. Marta bought \( v \) tapes for $45. Write an algebraic expression for the average cost of each tape.

13. A 5-foot pine tree was planted and grew 2 feet each year. Write an algebraic expression for the height of the tree after \( t \) years.

Practice and Problem Solving

Write each phrase as an algebraic expression.

14. \( m \) plus the product of 6 and \( n \)

15. the quotient of 23 and \( u \) minus \( t \)

16. 14 less than the quantity \( k \) times 6

17. 2 times the sum of \( y \) and 5

18. the quotient of 100 and the quantity 6 plus \( w \)

19. 35 multiplied by the quantity \( r \) less 45

20. 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?

21. Career Karen earns $65,000 a year as an optometrist. She received a bonus of \( b \) dollars last year and expects to get double that amount as a bonus this year. Write an algebraic expression to show the total amount Karen expects to earn this year.
Write a verbal expression for each algebraic expression.

22. \( h + 3 \)  
23. \( 90 \div y \)  
24. \( s - 405 \)  
25. \( 16t \)
26. \( 5(a - 8) \)  
27. \( 4p - 10 \)  
28. \( (r + 1) \div 14 \)  
29. \( \frac{m}{15} + 3 \)

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

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

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

33. **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?

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

35. **Challenge** In 1996, one U.S. dollar was equivalent, on average, to \$1.363 in Canadian money. Write an algebraic expression for the number of U.S. dollars you could get for \( n \) Canadian dollars.

36. **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 \( x \)

37. **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 per night for a family of four staying at the inn. Then evaluate your expression for 3 nights.

**Simplify each expression.** (Lesson 1-5)

38. \( 6 + 4 \div 2 \)  
39. \( 9 \cdot 1 - 4 \)  
40. \( 5^2 - 3 \)  
41. \( 24 \div 3 + 3^3 \)

42. Evaluate \( b - a^2 \) for \( a = 2 \) and \( b = 9 \). (Lesson 1-7)
Learn to simplify algebraic expressions.

Vocabulary
- term
- coefficient

Individual skits at the talent show can last up to \( x \) minutes each, and group skits can last up to \( y \) minutes each. Intermission will be 15 minutes. The expression \( 7x + 9y + 15 \) represents the maximum length of the talent show if 7 individuals and 9 groups perform.

In the expression \( 7x + 9y + 15 \), \( 7x \), \( 9y \), and 15 are terms. A term can be a number, a variable, or a product of numbers and variables. Terms in an expression are separated by plus or minus signs.

In the term \( 7x \), 7 is called the coefficient. A coefficient is a number that is multiplied by a variable in an algebraic expression.

Like terms are terms with the same variable raised to the same power. The coefficients do not have to be the same. Constants, like 5, \( \frac{1}{2} \), and 3.2, are also like terms.

<table>
<thead>
<tr>
<th>Like Terms</th>
<th>3x and 2x</th>
<th>( \frac{w}{7} )</th>
<th>5 and 1.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlike Terms</td>
<td>5x(^2) and 2x</td>
<td>6a and 6b</td>
<td>3.2 and ( n )</td>
</tr>
</tbody>
</table>

The exponents are different. The variables are different. Only one term contains a variable.

Identifying Like Terms

Identify like terms in the list.

\[ 5a, \quad \frac{t}{2}, \quad 3y^2, \quad 7t, \quad x^2, \quad 4z, \quad k, \quad 4.5y^2, \quad 2t, \quad \frac{2}{3}a \]

Look for like variables with like powers.

Like terms: \( 5a \) and \( \frac{2}{3}a \), \( \frac{t}{2}, \) and \( 7t \), \( 3y^2 \) and \( 4.5y^2 \)
To simplify an algebraic expression that contains like terms, combine the terms. Combining like terms is like grouping similar objects.

\[
\begin{array}{cccc}
\text{x} & \text{x} \\
\text{x} & \text{x} \\
\end{array} +
\begin{array}{cccc}
\text{x} & \text{x} & \text{x} & \text{x} \\
\text{x} & \text{x} & \text{x} & \text{x} \\
\end{array} =
\begin{array}{cccc}
\text{x} & \text{x} & \text{x} & \text{x} & \text{x} & \text{x} \\
\text{x} & \text{x} & \text{x} & \text{x} & \text{x} \\
\end{array}
\]

\[4x + 5x = 9x\]

To combine like terms that have variables, add or subtract the coefficients.

**Example 2**

**Simplifying Algebraic Expressions**

Simplify. Justify your steps using the Commutative, Associative, and Distributive Properties when necessary.

A. \(7x + 2x\)

\[
\begin{align*}
7x + 2x & = 9x \\
& \text{7x and 2x are like terms.} \\
& \text{Add the coefficients.}
\end{align*}
\]

B. \(5x^3 + 3y + 7x^3 - 2y - 4x^2\)

\[
\begin{align*}
5x^3 + 3y + 7x^3 - 2y - 4x^2 & = 12x^3 + y - 4x^2 \\
& \text{Identify like terms.} \\
5x^3 + 7x^3 + 3y - 2y - 4x^2 & = \text{Commutative Property} \\
(5x^3 + 7x^3) + (3y - 2y) - 4x^2 & = \text{Associative Property} \\
12x^3 + y - 4x^2 & = \text{Add or subtract the coefficients.}
\end{align*}
\]

C. \(2(a + 2a^2) + 2b\)

\[
\begin{align*}
2(a + 2a^2) + 2b & = 2a + 4a^2 + 2b \\
& \text{Distributive Property} \\
2a + 4a^2 + 2b & \text{There are no like terms to combine.}
\end{align*}
\]

**Example 3**

**Geometry Application**

Write an expression for the perimeter of the rectangle. Then simplify the expression.

\[
\begin{align*}
b + h + b + h & = \text{Write an expression using the side lengths.} \\
(b + b) + (h + h) & = \text{Identify and group like terms.} \\
2b + 2h & = \text{Add the coefficients.}
\end{align*}
\]

**Think and Discuss**

1. Explain whether \(5x, 5x^2,\) and \(5x^3\) are like terms.
2. Explain how you know when an expression cannot be simplified.
1-9 Exercises

GUIDED PRACTICE

See Example 1 Identify like terms in each list.
1. \(6b \ 5x^2 \ 4x^3 \ \frac{b}{2} \ x^2 \ 2e\)  
2. \(12a^2 \ 4x^3 \ b \ 4a^2 \ 3.5x^3 \ \frac{5}{6}b\)

See Example 2 Simplify. Justify your steps using the Commutative, Associative, and Distributive Properties when necessary.
3. \(5x + 3x\)  
4. \(6a^2 - a^2 + 16\)  
5. \(4a^2 + 5a + 14b\)

See Example 3 6. Geometry Write an expression for the perimeter of the rectangle. Then simplify the expression.

INDEPENDENT PRACTICE

See Example 1 Identify like terms in each list.
7. \(2b \ b^6 \ b \ x^4 \ 3b^6 \ 2x^2\)  
8. \(6 \ 2n \ 3n^2 \ 6m^2 \ \frac{n}{4} \ 7\)
9. \(10k^2 \ m \ 3^3 \ \frac{p}{6} \ 2m \ 2\)  
10. \(6^3 \ y^3 \ 3y^2 \ 6^2 \ y \ 5y^3\)

See Example 2 Simplify. Justify your steps using the Commutative, Associative, and Distributive Properties when necessary.
11. \(3a + 2b + 5a\)  
12. \(5b + 7b + 10\)  
13. \(a + 2b + 2a + b + 2c\)  
14. \(y + 4 + 2x + 3y\)  
15. \(q^2 + 2q + 2q^2\)  
16. \(18 + 2d^3 + d + 3d\)

See Example 3 17. Geometry Write an expression for the perimeter of the given figure. Then simplify the expression.

PRACTICE AND PROBLEM SOLVING

Extra Practice
See page 726.

Simplify each expression.
18. \(4x + 5x\)  
19. \(32y - 5y\)  
20. \(4c^2 + 5c + 2c\)  
21. \(5d^2 - 3d^2 + d\)  
22. \(5f^2 + 2f + f^2\)  
23. \(7x + 8x^2 - 3y\)  
24. \(p + 9q + 9 + 14p\)  
25. \(6b + 6b^2 + 4b^3\)  
26. \(a^2 + 2b + 2a^2 + b + 2c\)

27. Geometry Write an expression for the perimeter of the given triangle. Then evaluate the perimeter when \(n\) is 1, 2, 3, 4, and 5.
28. Critical Thinking  Determine whether the expression $9m^2 + k$ is equal to $7m^2 + 2(2k - m^2) + 5k$. Use properties to justify your answer.

29. Multi-Step  Brad makes $d$ dollars per hour as a cook at a deli. The table shows the number of hours he worked each week in June.

<table>
<thead>
<tr>
<th>Week</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21.5</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>15.5</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
</tr>
</tbody>
</table>

a. Write and simplify an expression for the amount of money Brad earned in June.
b. Evaluate your expression from part a for $d = $9.50.
c. What does your answer to part b represent?

30. Business  Ashley earns $8 per hour working at a grocery store. Last week she worked $h$ hours bagging groceries and twice as many hours stocking shelves. Write and simplify an expression for the amount Ashley earned.

31. Critical Thinking  The terms $3x$, $23x^2$, $6y^2$, $2x$, $y^2$ and one other term can be written in an expression which, when simplified, equals $5x + 7y^2$. Identify the term missing from the list and write the expression.

32. What’s the Question?  At one store, a pair of jeans costs $29 and a shirt costs $25. At another store, the same kind of jeans costs $26 and the same kind of shirt costs $20. The answer is $29j - 26j + 25s - 20s = 3j + 5s$. What is the question?

33. Write About It  Describe the steps for simplifying the expression $2x + 3 + 5x - 15$.

34. Challenge  A rectangle has a width of $x + 2$ and a length of $3x + 1$. Write and simplify an expression for the perimeter of the rectangle.

35. Multiple Choice  Translate “six times the sum of $x$ and $y$” and “five less than $y$.” Which algebraic expression represents the sum of these two verbal expressions?

- A  $6x + 5$
- B  $6x + 2y - 5$
- C  $6x + 5y + 5$
- D  $6x + 7y - 5$

36. Multiple Choice  The side length of a square is $2x + 3$. Which expression represents the perimeter of the square?

- F  $2x + 12$
- G  $4x + 6$
- H  $6x + 7$
- J  $8x + 12$

37. Compare. Write $<$, $>$, or $=$. (Lesson 1-3)

- 2.3 mm $<$ 23 cm
- 6 km $>$ 600 m
- 449 mg $<$ 0.5 g

38. Evaluate the expression $9y - 3$ for each given value of the variable. (Lesson 1-7)

- 40. $y = 2$
- 41. $y = 6$
- 42. $y = 10$
- 43. $y = 18$
Ella has 22 CDs. This is 9 more than Kay has. This situation can be written as an equation. An equation is a mathematical statement that two expressions are equal in value.

An equation is like a balanced scale.

\[ \text{Number of CDs Ella has} \quad \text{is equal to} \quad 9 \text{ more than Kay has.} \]

\[ 22 = j + 9 \]

Just as the weights on both sides of a balanced scale are exactly the same, the expressions on both sides of an equation represent exactly the same value.

When an equation contains a variable, a value of the variable that makes the statement true is called a solution of the equation.

- \[ 22 = j + 9 \quad j = 13 \text{ is a solution because } 22 = 13 + 9. \]
- \[ 22 = j + 9 \quad j = 15 \text{ is not a solution because } 22 \neq 15 + 9. \]

**EXAMPLE 1**

Determining Whether a Number Is a Solution of an Equation

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

A. \[ 18 = s - 7; s = 11 \]
   \[ 18 = s - 7 \]
   \[ 18 \overset{?}{=} 11 - 7 \quad \text{Substitute 11 for } s. \]
   \[ 18 \overset{?}{=} 4 \times \]
   11 is not a solution of \( 18 = s - 7 \).

B. \[ w + 17 = 23; w = 6 \]
   \[ w + 17 = 23 \]
   \[ 6 + 17 \overset{?}{=} 23 \quad \text{Substitute 6 for } w. \]
   \[ 23 \overset{?}{=} 23 \checkmark \]
   6 is a solution of \( w + 17 = 23 \).
**EXAMPLE 2**

**Writing an Equation to Determine Whether a Number Is a Solution**

Tyler wants to buy a new skateboard. He has $57, which is $38 less than he needs. Does the skateboard cost $90 or $95?

You can write an equation to find the price of the skateboard. If $s$ represents the price of the skateboard, then $s - 38 = 57$.

- **$90**
  
  \[
  s - 38 = 57 \\
  90 - 38 = 57 \\
  52 \neq 57 \times
  
  \]

- **$95**
  
  \[
  s - 38 = 57 \\
  95 - 38 = 57 \quad \text{Substitute 95 for } s. \\
  57 = 57 \checkmark 
  
  \]

The skateboard costs $95.

**EXAMPLE 3**

**Deriving a Real-World Situation from an Equation**

Which problem situation best matches the equation $3x + 4 = 22$?

**Situation A:**
Harvey spent $22 at the gas station. He paid $4 per gallon for gas and $3 for snacks. How many gallons of gas did Harvey buy?

The variable $x$ represents the number of gallons of gas that Harvey bought.

- $4 \text{ per gallon} \rightarrow 4x$

Since $4x$ is not a term in the given equation, Situation A does not match the equation.

**Situation B:**
Harvey spent $22 at the gas station. He paid $3 per gallon for gas and $4 for snacks. How many gallons of gas did Harvey buy?

- $3 \text{ per gallon} \rightarrow 3x$
- $4 \text{ on snacks} \rightarrow + 4$

Harvey spent $22 in all, so $3x + 4 = 22$. Situation B matches the equation.

**Think and Discuss**

1. **Compare** equations with expressions.
2. **Give an example** of an equation whose solution is 5.
Determine whether the given value of the variable is a solution.

1. $19 = x + 4; x = 23$
2. $6n = 78; n = 13$
3. $k ÷ 3 = 14; k = 42$
4. Mavis wants to buy a book. She has $25, which is $9 less than she needs. Does the book cost $34 or $38?
5. Which problem situation best matches the equation $10 + 2x = 16$?
   - **Situation A:** Angie bought peaches for $2 per pound and laundry detergent for $10. She spent a total of $16. How many pounds of peaches did Angie buy?
   - **Situation B:** Angie bought peaches for $10 per pound and laundry detergent for $2. She spent a total of $16. How many pounds of peaches did Angie buy?
6. $r ÷ 25; r = 37$
7. $39 ÷ x = 13; x = 4$
8. $21 = m + 9; m = 11$
9. $a ÷ 18 = 7; a = 126$
10. $16f = 48; f = 3$
11. $71 - y = 26; y = 47$
12. Curtis wants to buy a new snowboard. He has $119, which is $56 less than he needs. Does the snowboard cost $165 or $175?
13. Which problem situation best matches the equation $2m + 10 = 18$?
   - **Situation A:** A taxi service charges a $2 fee, plus $18 per mile. Jeremy paid the driver $10. How many miles did Jeremy ride in the taxi?
   - **Situation B:** A taxi service charges a $10 fee, plus $2 per mile. Jeremy paid the driver $18. How many miles did Jeremy ride in the taxi?
14. $j = 6$ for $15 - j = 21$
15. $x = 36$ for $48 = x + 12$
16. $m = 18$ for $16 = 34 - m$
17. $k = 23$ for $17 + k = 40$
18. $y = 8$ for $9y + 2 = 74$
19. $c = 12$ for $100 - 2c = 86$
20. $q = 13$ for $5q + 7 - q = 51$
21. $w = 15$ for $13w - 2 - 6w = 103$
22. $t = 12$ for $3(50 - t) - 10t = 104$
23. $r = 21$ for $4r - 8 + 9r - 1 = 264$
24. **Hobbies** Monique has a collection of stamps from 6 different countries. Jeremy has stamps from 3 fewer countries than Monique does. Write an equation showing this, using $j$ as the number of countries from which Jeremy has stamps.
Earth Science

25. The diagram shows approximate elevations for different climate zones in the Colorado Rockies. Use the diagram to write an equation that shows the vertical distance \( d \) from the summit of Mount Evans (14,264 ft) to the tree line, which marks the beginning of the alpine tundra zone.

26. The top wind speed of an F5 tornado, the strongest known kind of tornado, is 246 mi/h faster than the top wind speed of an F1 tornado, the weakest kind of tornado. The top wind speed of an F1 tornado is 72 mi/h. Is the top wind speed of an F5 tornado 174 mi/h, 218 mi/h, or 318 mi/h?

27. Write a Problem The mean surface temperature of Earth increased about 1°F from 1861 to 1998. In 1998, the mean surface temperature was about 60°F. Use this data to write a problem involving an equation with a variable.

28. Challenge In the 1980s, about 9.3 \( \times 10^4 \) acres of tropical forests were destroyed each year due to deforestation. About how many acres of tropical forests were destroyed during the 1980s?

---

Test Prep and Spiral Review

29. Multiple Choice Jack’s rectangular bedroom has a length of 10 feet. He used the formula \( A = 10w \) to find the area of his room. He found that his bedroom had an area of 150 square feet. What was the width of his bedroom?

A 15 feet  B 25 feet  C 30 feet  D 15,000 feet

30. Multiple Choice The number of seventh-graders at Pecos Middle School is 316. This is 27 more than the number of eighth-graders. How many eighth-graders are enrolled?

F 289  G 291  H 299  J 343

Write each number in scientific notation. (Lesson 1-4)

31. 10,850,000  32. 627,000  33. 9,040,000

Tell which property is represented. (Lesson 1-6)

34. \((7 + 5) + 3 = 7 + (5 + 3)\)  35. \(181 + 0 = 181\)  36. \(bc = cb\)
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 $3 + w = 11$.

   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 $3 + w = 11$.

   

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

   

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

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

50  Chapter 1 Algebraic Reasoning
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 $3y = 15$.

![Modeling Equations with Algebra Tiles]

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

![Dividing Tiles into Groups]

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

![Counting the Solution]

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.

- $3 + w = 11$  $3y = 15$
- $3 + 8 \div 11$  $3 \cdot 5 = 15$
- $11 = 11$ \(\checkmark\)  $15 = 15$ \(\checkmark\)

**Think and Discuss**

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

2. Compare using a balance scale and algebra tiles 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. $18 = 6p$
To solve an equation means to find a solution to the equation. To do this, isolate the variable—that is, get the variable alone on one side of the equal sign.

\[
\begin{align*}
\text{Addition Property of Equality} \\
x &= 8 - 5 \\
7 - 3 &= y \\
x + 5 &= 8 \\
7 &= 3 + y
\end{align*}
\]

The variables are isolated. The variables are not isolated.

Recall that an equation is like a balanced scale. If you increase or decrease the weights by the same amount on both sides, the scale will remain balanced.

Use inverse operations when isolating a variable. Addition and subtraction are inverse operations, which means that they “undo” each other.

**EXAMPLE 1**

**Solving an Equation by Addition**

Solve the equation \( x - 8 = 17 \). Check your answer.

\[
\begin{align*}
x - 8 &= 17 \\
+ 8 &+ 8 \\
x &= 25
\end{align*}
\]

**Check**

\[
\begin{align*}
x - 8 &= 17 \\
25 - 8 &= 17 \\
17 &
\]

Substitute 25 for \( x \).

25 is a solution.
Solving an Equation by Subtraction

Solve the equation \(a + 5 = 11\). Check your answer.

\[a + 5 = 11\]

Think: 5 is added to \(a\), so subtract 5 from both sides to isolate \(a\).

\[\begin{align*}
-5 & \quad -5 \\
\hline
a & \quad 6
\end{align*}\]

Check

\[\begin{align*}
a + 5 & = 11 \\
6 + 5 & = 11 \\
11 & = 11
\end{align*}\]

6 is a solution.

Sports Application

Michael Jordan’s highest point total for a single game was 69. The entire team scored 117 points in that game. How many points did his teammates score?

Let \(p\) represent the points scored by the rest of the team.

\[\begin{align*}
\text{Jordan’s points} + \text{Teammates’ points} & = \text{Final score} \\
69 + p & = 117
\end{align*}\]

Subtract 69 from both sides to isolate \(p\).

\[\begin{align*}
-69 & \quad -69 \\
\hline
p & \quad 48
\end{align*}\]

His teammates scored 48 points.

Think and Discuss

1. Explain how to decide which operation to use in order to isolate the variable in an equation.

2. Describe what would happen if a number were added or subtracted on one side of an equation but not on the other side.
GUARDIAN PRACTICE
See Example 1
Solve each equation. Check your answer.
1. \( r - 77 = 99 \)  
2. \( 102 = v - 66 \)  
3. \( x - 22 = 66 \)
See Example 2
4. \( d + 83 = 92 \)  
5. \( 45 = 36 + f \)  
6. \( 987 = 16 + m \)
See Example 3
7. After a gain of 9 yards, your team has gained a total of 23 yards. How many yards had your team gained before the 9-yard gain?

INDEPENDENT PRACTICE
See Example 1
Solve each equation. Check your answer.
8. \( n - 36 = 17 \)  
9. \( t - 28 = 54 \)  
10. \( p - 56 = 12 \)
11. \( b - 41 = 26 \)  
12. \( m - 51 = 23 \)  
13. \( k - 22 = 101 \)
See Example 2
14. \( x + 15 = 43 \)  
15. \( w + 19 = 62 \)  
16. \( a + 14 = 38 \)
17. \( 110 = s + 65 \)  
18. \( x + 47 = 82 \)  
19. \( 18 + f = 94 \)
20. \( 97 = t + 45 \)  
21. \( q + 13 = 112 \)  
22. \( 44 = 16 + n \)
See Example 3
23. Hank is on a field trip. He has to travel 56 miles to reach his destination. He has traveled 18 miles so far. How much farther does he have to travel?
24. Sandy read 8 books in April. If her book club requires her to read 6 books each month, how many more books did she read than what was required?

PRACTICE AND PROBLEM SOLVING
Solve each equation. Check your answer.
25. \( p - 7 = 3 \)  
26. \( n + 17 = 98 \)  
27. \( 23 + b = 75 \)
28. \( 356 = y - 219 \)  
29. \( 105 = a + 60 \)  
30. \( g - 720 = 159 \)
31. \( 651 + c = 800 \)  
32. \( f - 63 = 937 \)  
33. \( 59 + m = 258 \)
34. \( 16 = h - 125 \)  
35. \( s + 841 = 1,000 \)  
36. \( 711 = q - 800 \)
37. \( 63 + x = 902 \)  
38. \( z - 712 = 54 \)  
39. \( 120 = w + 41 \)

40. Physical Science An object weighs less when it is in water. This is because water exerts a buoyant force on the object. The weight of an object out of water is equal to the object’s weight in water plus the buoyant force of the water. Suppose an object weighs 103 pounds out of water and 55 pounds in water. Write and solve an equation to find the buoyant force of the water.

41. Banking After Lana deposited a check for $65, her new account balance was $315. Write and solve an equation to find the amount that was in Lana’s account before the deposit.
42. **Music** Jason wants to buy the trumpet advertised in the classified ads. He has saved $156. Using the information from the ad, write and solve an equation to find how much more money he needs to buy the trumpet.

43. **What's the Error?** Describe and correct the error.
   \[ x = 50 \text{ for } (8 + 4)2 + x = 26 \]

44. **Write About It** Explain how you know whether to add or subtract to solve an equation.

45. **Challenge** Kwan keeps a record of his football team's gains and losses on each play of the game. The record is shown in the table. Find the missing information by writing and solving an equation.

<table>
<thead>
<tr>
<th>Play</th>
<th>Play Gain/Loss</th>
<th>Overall Gain/Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st down</td>
<td>Gain of 2 yards</td>
<td>Gain of 2 yards</td>
</tr>
<tr>
<td>2nd down</td>
<td>Loss of 5 yards</td>
<td>Loss of 3 yards</td>
</tr>
<tr>
<td>3rd down</td>
<td>Gain of 7 yards</td>
<td>Gain of 4 yards</td>
</tr>
<tr>
<td>4th down</td>
<td></td>
<td>Loss of 7 yards</td>
</tr>
</tbody>
</table>

46. **Gridded Response** Morgan has read 78 pages of *Treasure Island*. The book has 203 pages. How many pages of the book does Morgan have left to read?

47. **Multiple Choice** Which problem situation best represents the equation \( 42 - x = 7 \)?

   - A. Craig is 42 years old. His brother is 7 years older than he is. How old is Craig's brother?
   - B. Dylan has 42 days to finish his science fair project. How many weeks does he have left to finish his project?
   - C. The total lunch bill for a group of 7 friends is $42. If the friends split the cost of the meal evenly, how much should each person pay?
   - D. Each student in the Anderson Junior High Spanish Club has paid for a club T-shirt. If there are 42 students in the club and only 7 shirts are left to be picked up, how many students have already picked up their shirts?

48. Write each phrase as an algebraic expression. (Lesson 1-8)

   - the product of 16 and \( n \)
   - 17 decreased by \( k \)
   - 8 times the sum of \( x \) and 4

49. Simplify each expression. (Lesson 1-9)

   - \( 6(2 + 2n) + 3n \)
   - \( 4x - 7y + x \)
   - \( 8 + 3n + 2(4t) \)
**1-12 Multiplication and Division Equations**

Learn to solve one-step equations by using multiplication or division.

**Vocabulary**

**Multiplication Property of Equality**

**Division Property of Equality**

Like addition and subtraction, multiplication and division are inverse operations. They “undo” each other.

<table>
<thead>
<tr>
<th>MULTIPLICATION PROPERTY OF EQUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Words</strong></td>
</tr>
<tr>
<td>You can multiply both sides of an equation by the same number, and the statement will still be true.</td>
</tr>
<tr>
<td><strong>Numbers</strong></td>
</tr>
<tr>
<td>3 \cdot 4 = 12</td>
</tr>
<tr>
<td>2 \cdot 3 \cdot 4 = 2 \cdot 12</td>
</tr>
<tr>
<td>6 \cdot 4 = 24</td>
</tr>
<tr>
<td><strong>Algebra</strong></td>
</tr>
<tr>
<td>( x = y )</td>
</tr>
<tr>
<td>( 2x = 2y )</td>
</tr>
</tbody>
</table>

If a variable is divided by a number, you can often use multiplication to isolate the variable. Multiply both sides of the equation by the number.

**Example 1**

Solving an Equation by Multiplication

Solve the equation \( \frac{x}{7} = 20 \). Check your answer.

\[
\frac{x}{7} = 20
\]

\[
(7) \frac{x}{7} = 20(7) \quad \text{Think: } x \text{ is divided by } 7, \text{ so multiply both sides by } 7 \text{ to isolate } x.
\]

\[
x = 140
\]

Check

\[
\frac{x}{7} = 20
\]

\[
\frac{140}{7} = 20 \quad \sub \text{Substitute } 140 \text{ for } x.
\]

\[
20 = 20 \checkmark \quad 140 \text{ is a solution.}
\]

<table>
<thead>
<tr>
<th>DIVISION PROPERTY OF EQUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Words</strong></td>
</tr>
<tr>
<td>You can divide both sides of an equation by the same nonzero number, and the statement will still be true.</td>
</tr>
<tr>
<td><strong>Numbers</strong></td>
</tr>
<tr>
<td>5 \cdot 6 = 30</td>
</tr>
</tbody>
</table>
| \[
\frac{5 \cdot 6}{3} = \frac{30}{3}
\] |
| 5 \cdot \frac{6}{3} = 10       |
| 5 \cdot 2 = 10                 |
| **Algebra**                   |
| \( x = y \)                    |
| \( \frac{x}{z} = \frac{y}{z} \) |
| \( z \neq 0 \)                 |

Remember! You cannot divide by 0.
If a variable is multiplied by a number, you can often use division to isolate the variable. Divide both sides of the equation by the number.

**EXAMPLE 2**

**Solving an Equation by Division**

Solve the equation \( 240 = 4z \). Check your answer.

\[
\begin{align*}
240 &= 4z \\
\frac{240}{4} &= \frac{4z}{4} \\
60 &= z \\

\text{Check} \\
240 &= 4z \\
240 &= 4(60) \\
240 &= 240 \checkmark
\end{align*}
\]

\( 60 \) is a solution.

**EXAMPLE 3**

**Health Application**

If you count your heartbeats for 10 seconds and multiply that number by 6, you can find your heart rate in beats per minute. Lance Armstrong, who won the Tour de France seven years in a row, from 1999 to 2005, has a resting heart rate of 30 beats per minute. How many times does his heart beat in 10 seconds?

Use the given information to write an equation, where \( b \) is the number of heartbeats in 10 seconds.

\[
6b = 30
\]

\( 6b = 30 \) \hspace{1cm} \text{Think: } b \text{ is multiplied by 6, so divide both sides by 6 to isolate } b.

\[
\frac{6b}{6} = \frac{30}{6} \\
b = 5
\]

Lance Armstrong’s heart beats 5 times in 10 seconds.

**Think and Discuss**

1. **Explain** how to check your solution to an equation.
2. **Describe** how to solve \( 13x = 91 \).
3. When you solve \( 5p = 35 \), will \( p \) be greater than 35 or less than 35? **Explain** your answer.
4. When you solve \( \frac{p}{5} = 35 \), will \( p \) be greater than 35 or less than 35? **Explain** your answer.
1. \( \frac{s}{77} = 11 \)
2. \( b + 25 = 4 \)
3. \( y + 8 = 5 \)
4. \( 72 = 8x \)
5. \( 3c = 96 \)
6. \( x \cdot 18 = 18 \)

7. On Friday nights, a local bowling alley charges $5 per person to bowl all night. If Carol and her friends paid a total of $45 to bowl, how many people were in their group?

8. \( 12 = s + 4 \)
9. \( \frac{k}{18} = 72 \)
10. \( 13 = \frac{g}{5} \)
11. \( \frac{c}{5} = 35 \)
12. \( \frac{w}{11} = 22 \)
13. \( 17 = n + 18 \)
14. \( 17x = 85 \)
15. \( 63 = 3p \)
16. \( 6u = 222 \)
17. \( 97a = 194 \)
18. \( 9q = 108 \)
19. \( 495 = 11d \)

20. It costs $6 per ticket for groups of ten or more people to see a minor league baseball game. If Albert’s group paid a total of $162 for game tickets, how many people were in the group?

21. \( 9 = g + 3 \)
22. \( 150 = 3f \)
23. \( 68 = m - 42 \)
24. \( 7r = 84 \)
25. \( 5x = 35 \)
26. \( 9 = \frac{s}{38} \)
27. \( b + 33 = 95 \)
28. \( \frac{p}{15} = 6 \)
29. \( 12f = 240 \)
30. \( 504 = c - 212 \)
31. \( 8a = 288 \)
32. \( 157 + q = 269 \)
33. \( 21 = d + 2 \)
34. \( \frac{h}{20} = 83 \)
35. \( r - 92 = 215 \)

**Multi-Step** Translate each sentence into an equation. Then solve the equation.

36. A number \( d \) divided by 4 equals 3.
37. The sum of 7 and a number \( n \) is 15.
38. The product of a number \( b \) and 5 is 250.
39. Twelve is the difference of a number \( q \) and 8.
40. **Consumer Math** Nine weeks from now Susan hopes to buy a bicycle that costs $180. How much money must she save per week?
41. **School**  A school club is collecting toys for a children's charity. There are 18 students in the club. The goal is to collect 216 toys. Each member will collect the same number of toys. How many toys should each member collect?

42. **Travel**  Lissa drove from Los Angeles to New York City and averaged 45 miles per hour. Her driving time totaled 62 hours. Write and solve an equation to find the distance Lissa traveled.

43. **Business**  A store rents space in a building at a cost of $19 per square foot. If the store is 700 square feet, how much is the rent?

44. **What’s the Error?**  For the equation $7x = 56$, a student found the value of $x$ to be 392. What was the student's error?

45. **Write About It**  How do you know whether to use multiplication or division to solve an equation?

46. **Challenge**  The graph shows the results of a survey about electronic equipment used by 8,690,000 college students. If you multiply the number of students who use portable CD players by 5 and then divide by 3, you get the total number of students represented by the survey. Write and solve an equation to find the number of students who use portable CD players.

---

**TEST PREP and Spiral Review**

47. **Multiple Choice**  Mr. Tomkins borrowed $1,200 to buy a computer. He wants to repay the loan in 8 equal payments. How much will each payment be?

   - A) $80
   - B) $100
   - C) $150
   - D) $200

48. **Multiple Choice**  Solve the equation $16x = 208$.

   - F) $x = 11$
   - G) $x = 12$
   - H) $x = 13$
   - J) $x = 14$

49. **Extended Response**  It costs $18 per ticket for groups of 20 or more people to enter an amusement park. If Celia's group paid a total of $414 to enter, how many people were in her group?

Determine whether the given value of the variable is a solution.  (Lesson 1-10)

50. $x + 34 = 48; x = 14$

51. $d - 87 = 77; d = 10$

Solve each equation.  (Lesson 1-11)

52. $76 + n = 115$

53. $j - 97 = 145$

54. $t - 123 = 455$

55. $a + 39 = 86$
Quiz for Lessons 1-7 Through 1-12

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

1-8 Translate Words into Math
Write each phrase as an algebraic expression.
4. the quotient of a number and 15
5. a number decreased by 13
6. 10 times the difference of $p$ and 2
7. 3 plus the product of a number and 8
8. 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.

1-9 Simplifying Algebraic Expressions
Simplify each expression. Justify your steps.
9. $2y + 5y^2 - 2y^2$
10. $x + 4 + 7x + 9$
11. $10 + 9b - 6a - b$
12. Write an expression for the perimeter of the given figure. Then simplify the expression.

1-10 Equations and Their Solutions
Determine whether the given value of the variable is a solution.
13. $22 - x = 7$; $x = 15$
14. $\frac{56}{r} = 8$; $r = 9$
15. $m + 19 = 47$; $m = 28$
16. Last month Sue spent $147 on groceries. This month she spent $29 more on groceries than last month. Did Sue spend $118 or $176 on groceries this month?

1-11 Addition and Subtraction Equations
Solve each equation.
17. $g - 4 = 13$
18. $20 = 7 + p$
19. $t - 18 = 6$
20. $m + 34 = 53$

1-12 Multiplication and Division Equations
Solve each equation.
21. $\frac{k}{8} = 7$
22. $3b = 39$
23. $n + 16 = 7$
24. $330 = 22x$
25. A water jug holds 128 fluid ounces. How many 8-ounce servings of water does the jug hold?
**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.

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.

<table>
<thead>
<tr>
<th>Maximum Heart Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>35</td>
</tr>
</tbody>
</table>
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 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 other beans 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.
Step-by-Step Algebra

This “step book” is a great place to record sample algebra problems.

Directions

1. Lay the 11\(\frac{1}{2}\)-by-7\(\frac{3}{4}\)-inch sheet of paper in front of you. Fold it down 2\(\frac{1}{2}\) inches from the top and make a crease. Figure A

2. Slide the 7\(\frac{1}{2}\)-by-7\(\frac{3}{4}\)-inch sheet of paper under the flap of the first piece. Do the same with the 5\(\frac{1}{2}\)-by-7\(\frac{3}{4}\)-inch and 3\(\frac{3}{4}\)-by-7\(\frac{3}{4}\)-inch sheets of paper to make a step book. Staple all of the sheets together at the top. Figure B

3. Use a pencil to divide the three middle sheets into thirds. Then cut up from the bottom along the lines you drew to make slits in these three sheets. Figure C

4. On the top step of your booklet, write the number and title of the chapter.

Taking Note of the Math

Label each of the steps in your booklet with important concepts from the chapter: “Using Exponents,” “Expressing Numbers in Scientific Notation,” and so on. On the bottom sheet, write “Solving Equations.” Write sample problems from the chapter on the appropriate steps.
Complete the sentences below with vocabulary words from the list above.

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 the pattern to write the next three numbers.

2, 8, 14, 20, ...

\[ \begin{align*}
2 + 6 &= 8 \\
8 + 6 &= 14 \\
14 + 6 &= 20
\end{align*} \]

A possible pattern is to add 6 each time.

\[ \begin{align*}
20 + 6 &= 26 \\
26 + 6 &= 32 \\
32 + 6 &= 38
\end{align*} \]

**Exercises**

Identify a possible pattern. Use the 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. \( 11^2 \)
1-3 Metric Measurements (pp. 14–17)

**Example**

- Convert 63 m to centimeters.

\[ 63 \text{ m} = (63 \times 100) \text{ cm} \]

\[ = 6,300 \text{ cm} \]

**Exercises**

Convert each measure.

16. 18 L to mL
17. 720 mg to g
18. 5.3 km to m
19. 0.6 cm to mm

1-4 Applying Exponents (pp. 18–21)

**Example**

- Multiply \(157 \times 10^4\).

\[ 157 \times 10^4 = 1,570,000 \]

**Exercises**

Multiply.

20. \(144 \times 10^2\)
21. \(1.32 \times 10^3\)
22. \(22 \times 10^7\)

Write each number in scientific notation.

23. \(48,000\)
24. \(7,020,000\)
25. \(149,000\)

1-5 Order of Operations (pp. 23–26)

**Example**

- Simplify \((18 + 6) \times 5\).

\[ (18 + 6) \times 5 = 24 \times 5 = 120 \]

**Exercises**

Simplify each expression.

26. \(2 + (9 - 6) \div 3\)
27. \(12 \times 3^2 - 5\)
28. \(11 + 2 - 5 - (9 + 7)\)
29. \(75 \div 5^2 + 8^2\)

1-6 Properties (pp. 28–31)

**Example**

- Tell which property is represented.

\[ (10 \times 13) \times 28 = 10 \times (13 \times 28) \]

Associative Property

**Exercises**

Tell which property is represented.

30. \(42 + 17 = 17 + 42\)
31. \(m + 0 = m\)
32. \(6 \times (x - 5) = 6 \times x - 6 \times 5\)

1-7 Variables and Algebraic Expressions (pp. 34–37)

**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.

33. \(4x - 5\) for \(x = 6\)
34. \(8y^3 + 3y\) for \(y = 4\)
35. \(\frac{n}{5} + 6m - 3\) for \(n = 5\) and \(m = 2\)
1-8 Translate Words into Math (pp. 38–41)

**EXAMPLE**
- Write as an algebraic expression.
  5 times the sum of a number and 6
  \[5(n + 6)\]

**EXERCISES**
- Write as an algebraic expression.
  36. 4 divided by the sum of a number and 12
  37. 2 times the difference of \(t\) and 11

1-9 Simplifying Algebraic Expressions (pp. 42–45)

**EXAMPLE**
- Simplify the expression.
  \[\frac{4x^3 + 5y + 8x^3 - 4y - 5x^2}{12x^3 + y - 5x^2}\]

**EXERCISES**
- Simplify each expression.
  38. \[\frac{7b^2 + 8 + 3b^2}{3b^2}\]
  39. \[\frac{12a^2 + 4 + 3a^2 - 2}{5a^2}\]
  40. \[x^2 + x^3 + x^4 + 5x^2\]

1-10 Equations and Their Solutions (pp. 46–49)

**EXAMPLE**
- Determine whether 22 is a solution.
  \[24 \div s - 13\]
  \[24 \div 22 - 13\]
  \[24 \div 9 \times 22\]
  \[22 \text{ is not a solution.}\]

**EXERCISES**
- Determine whether the given value of the variable is a solution.
  41. \[36 = n - 12; n = 48\]
  42. \[9x = 117; x = 12\]

1-11 Addition and Subtraction Equations (pp. 52–55)

**EXAMPLE**
- Solve the equation. Then check.
  \[b + 12 = 16\]
  \[\begin{array}{c}
  -12 \\
  -12 \\
  \end{array}\]
  \[b = 4\]

**EXERCISES**
- Solve each equation. Then check.
  43. \[8 + b = 16\]
  44. \[20 = n - 12\]
  45. \[27 + c = 45\]
  46. \[t - 68 = 44\]

1-12 Multiplication and Division Equations (pp. 56–59)

**EXAMPLE**
- Solve the equation. Then check.
  \[2r = 12\]
  \[\begin{array}{c}
  \frac{2r}{2} \\
  \frac{12}{2} \\
  \end{array}\]
  \[r = 6\]

**EXERCISES**
- Solve each equation. Then check.
  47. \[n + 12 = 6\]
  48. \[3p = 27\]
  49. \[\frac{d}{14} = 7\]
  50. \[6x = 78\]
  51. Lee charges $8 per hour to baby-sit. Last month she earned $136. How many hours did Lee baby-sit last month?
Identify a possible pattern. Use the 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. $3^5$

Convert each measure.

9. 180 mL to liters  
10. 7.8 m to centimeters  
11. 23.4 kg to grams

12. Jesse is 1,460 millimeters tall. Her sister is 168 centimeters tall, and her brother is 1.56 meters tall. Who is the tallest?

Multiply.

13. $148 \cdot 10^2$  
14. $56.3 \cdot 10^3$  
15. $6.89 \cdot 10^4$  
16. $7.5 \cdot 10^4$

Write each number in scientific notation.

17. 406,000,000  
18. 1,905,000  
19. 22,400  
20. 500,000

Simplify each expression.

21. $18 \cdot 3 + 3^3$  
22. $36 + 16 - 50$  
23. $149 - (2^8 - 200)$  
24. $(4 + 2) \cdot 9 + 11$

Tell which property is represented.

25. $0 + 45 = 45$  
26. $(r + s) + t = r + (s + t)$  
27. $84 \cdot 3 = 3 \cdot 84$

Evaluate each expression for the given values of the variables.

28. $4a + 6b + 7$ for $a = 2$ and $b = 3$  
29. $7y^2 + 7y$ for $y = 3$

Write each phrase as an algebraic expression.

30. a number increased by 12  
31. the quotient of a number and 7  
32. 5 less than the product of 7 and $s$  
33. the difference between 3 times $x$ and 4

Simplify each expression. Justify your steps.

34. $b + 2 + 5b$  
35. $16 + 5b + 3b + 9$  
36. $5a + 6t + 9 + 2a$

Solve each equation.

37. $x + 9 = 19$  
38. $21 = y - 20$  
39. $m - 54 = 72$  
40. $136 = y + 114$

41. $16 = \frac{y}{3}$  
42. $102 = 17y$  
43. $\frac{r}{7} = 1,400$  
44. $6x = 42$

45. A caterer charged $15 per person to prepare a meal for a banquet. If the total catering charge for the banquet was $1,530, how many people attended?
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 $x + 7 = 15$?

- $x = 22$
- $x = 15$
- $x = 8$
- $x = 7$

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

**Use number sense:**
When you add, you get a greater number than what you started with. 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**

Arnold measured 0.15 L of water and then poured the water into a beaker labeled only in milliliters. What did the measurement read on the beaker?

- 0.015 mL
- 0.15 mL
- 15 mL
- 150 mL

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

**Use mental math:**
A milliliter is smaller than a liter, so the answer is greater than 0.15. You can eliminate answer choices F and G.

The prefix *milli-* means “thousandth,” so multiply 0.15 by 1,000 to get 150 mL, which is answer choice J.
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?

- F $10$
- G $16$
- H $512$
- I $1,023$

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 F?

**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**
A window in a treehouse measures 56 centimeters wide. Samantha wants to build a seat along the window that is 35 centimeters wider than the window is. How wide, in meters, would the window seat need to be?

- F $91\text{ m}$
- G $21\text{ m}$
- H $0.21\text{ m}$
- I $0.91\text{ m}$

7. Which two choices can be eliminated by using mental math?

8. Explain how to convert from centimeters to meters.

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

- A $0$
- B $11$
- C $17$
- D $21$

9. Use mental math to quickly eliminate one answer choice. Explain your choice.

10. What common error was made in finding answer choice B?

11. 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 \( z = 12? \)
   \( \begin{align*}
   &\text{A} \quad 4xyz \\
   &\text{B} \quad x + 5y + 2z \\
   &\text{C} \quad 2xz - 3y \\
   &\text{D} \quad 6xyz + 8
   \end{align*} \)

2. What is the next number in the pattern?
   \( 3, 3^2, 3^4, 3^5, \ldots \)
   \( \begin{align*}
   &\text{A} \quad 729 \\
   &\text{B} \quad 3^7 \\
   &\text{C} \quad 243 \\
   &\text{D} \quad 3^8
   \end{align*} \)

3. A contractor charges \$22\) to install one miniblind. How much does the contractor charge to install \( m \) miniblinds?
   \( \begin{align*}
   &\text{A} \quad 22m \\
   &\text{B} \quad \frac{22}{m} \\
   &\text{C} \quad 22 + m \\
   &\text{D} \quad \frac{22}{m}
   \end{align*} \)

4. Which of the following is an example of the Commutative Property?
   \( \begin{align*}
   &\text{A} \quad 20 + 10 = 2(10 + 5) \\
   &\text{B} \quad 20 + 10 = 10 + 20 \\
   &\text{C} \quad 5 + (20 + 10) = (5 + 20) + 10 \\
   &\text{D} \quad 20 + 0 = 20
   \end{align*} \)

5. Which expression simplifies to \( 9x + 3 \) when you combine like terms?
   \( \begin{align*}
   &\text{A} \quad 10x^2 - x^2 - 3 \\
   &\text{B} \quad 3x + 7 - 4 + 3x \\
   &\text{C} \quad 18 + 4x - 15 + 5x \\
   &\text{D} \quad 7x^2 + 2x + 6 - 3
   \end{align*} \)

6. What is the solution to the equation \( 810 = x - 625? \)
   \( \begin{align*}
   &\text{A} \quad x = 185 \\
   &\text{B} \quad x = 215 \\
   &\text{C} \quad x = 845 \\
   &\text{D} \quad x = 1,435
   \end{align*} \)

7. Tia maps out her jogging route as shown in the table. How many kilometers does Tia plan to jog?

   \( \begin{array}{|c|c|}
   \hline
   \text{Tia’s Jogging Route} & \\
   \text{Street} & \text{Meters} \\
   \hline
   \text{1st to Park} & 428 \\
   \text{Park to Windsor} & 112 \\
   \text{Windsor to East} & 506 \\
   \text{East to Manor} & 814 \\
   \text{Manor to Vane} & 660 \\
   \text{Vane to 1st} & 480 \\
   \hline
   \end{array} \)

   \( \begin{align*}
   &\text{A} \quad 3,000 \text{ km} \\
   &\text{B} \quad 300 \text{ km} \\
   &\text{C} \quad 30 \text{ km} \\
   &\text{D} \quad 3 \text{ km}
   \end{align*} \)

8. To make a beaded necklace, Kris needs 88 beads. If Kris has 1,056 beads, how many necklaces can she make?
   \( \begin{align*}
   &\text{A} \quad 968 \\
   &\text{B} \quad 264 \\
   &\text{C} \quad 12 \\
   &\text{D} \quad 8
   \end{align*} \)

9. What are the next two numbers in the pattern?
   \( 75, 70, 60, 55, 45, 40, \ldots \)
   \( \begin{align*}
   &\text{A} \quad 35, 30 \\
   &\text{B} \quad 30, 20 \\
   &\text{C} \quad 30, 25 \\
   &\text{D} \quad 35, 25
   \end{align*} \)

10. Marc spends \$78 for \( n \) shirts. Which expression can be used to represent the cost of one shirt?
    \( \begin{align*}
    &\text{A} \quad \frac{78}{n} \\
    &\text{B} \quad \frac{78}{n} \\
    &\text{C} \quad 78n \\
    &\text{D} \quad 78 + n
    \end{align*} \)
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. $3 + 1$

Hot Tip: When you read a word problem, cross out any information that is not needed to solve the problem.

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

14. What is the exponent when you write the number 23,000,000 in scientific notation?

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.