Chapter 5
Expressions

Essential Question
HOW can you use numbers and symbols to represent mathematical ideas?

Common Core State Standards
Content Standards
7.EE.1, 7.EE.2, 7.NS.3
Mathematical Practices
1, 2, 3, 4, 5, 6, 7

Math in the Real World
Meerkats live in burrows. Because meerkats have sharp claws, they are able to dig at a rate of 1 foot per second.
Suppose a meerkat digs for 3 seconds. Cross out the expression that does not represent the underground distance dug by the meerkat.

Foldables Study Organizer
1. Cut out the Foldable on page FL3 of this book.
2. Place your Foldable on page 426.
3. Use the Foldable throughout this chapter to help you learn about expressions.
Review Vocabulary

Order of Operations  The order of operations is a four-step process used to evaluate numerical expressions.

1. Evaluate the expressions inside grouping symbols.
2. Evaluate all powers.
3. Multiply and divide in order from left to right.
4. Add and subtract in order from left to right.

Use the order of operations to evaluate $3 + 5^2(4 + 4)$. Write each step in the organizer below.

Step 1

Step 2

Step 3

Step 4

$3 + 5^2(4 + 4)$
Read each statement. Decide whether you agree (A) or disagree (D). Place a checkmark in the appropriate column and then justify your reasoning.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Expressions</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like terms are terms that contain different variables.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When addition or subtraction signs separate an algebraic expression into parts, each part is called a term.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>An algebraic expression is in simplest form if it has no like terms and no parentheses.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A property is an example that shows that a conjecture is false.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When you use the Distributive Property to combine like terms, you are simplifying the expression.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent expressions have the same value.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**When Will You Use This?**

Here are a few examples of how expressions are used in the real world.

**Activity 1** Do you or your parents have a texting plan? If so, how much does it cost per text or per month? Ask your parents to help you research different texting plans. Then compare and contrast each plan.

**Activity 2** Go online at connectED.mcgraw-hill.com to read the graphic novel *Too Many Texts*. How many text messages are included in Dario’s texting plan?
Example 1
Evaluate $2^5$.
\[2^5 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32\]

Example 2
Write $3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$ in exponential form.
3 is the base. It is used as a factor 7 times. So, the exponent is 7.
\[3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 3^7\]

Example 3
Find $4(-2)$.
$4(-2) = -8$
The integers have different signs.
The product is negative.

Example 4
Find $-5(-8)$.
$-5(-8) = 40$
The integers have the same signs.
The product is positive.

Quick Check
Exponents Evaluate each expression.
1. $2^4 =$
2. $3^3 =$
3. $4^2 =$

4. Write $4 \cdot 4 \cdot 4 \cdot 4$ in exponential form.

Integer Operations Multiply.
5. $5(-10) =$
6. $-9(-4) =$
7. $-5^2 =$

How Did You Do?
Which problems did you answer correctly in the Quick Check?
Shade those exercise numbers below.
1 2 3 4 5 6 7
A **variable** is a symbol that represents an unknown quantity. An **algebraic expression**, such as \( n + 2 \), is an expression that contains variables, numbers, and at least one operation.

![Variable] \( n + 2 \)

Write each of the following phrases in the correct section of the Venn diagram: **contains an operation**, **has variables and numbers**, **has only numbers**.

**Characteristics of Expressions**
- numerical expression
- algebraic expression

**Real-World Link**

The expression \((F - 32) \times \frac{5}{9}\) can be used to convert a temperature from Fahrenheit to Celsius. In this algebraic expression, the variable \( F \) represents the temperature in degrees Fahrenheit.

**Which **Mathematical Practices** did you use?**

Shade the circle(s) that applies.

1. Persevere with Problems
2. Reason Abstractly
3. Construct an Argument
4. Model with Mathematics
5. Use Math Tools
6. Attend to Precision
7. Make Use of Structure
8. Use Repeated Reasoning
Evaluate an Algebraic Expression

The branch of mathematics that involves expressions with variables is called algebra. In algebra, the multiplication sign is often omitted.

\[
\begin{align*}
6d & \quad 9st & \quad mn & \quad a^3 \\
6 \text{ times } d & \quad 9 \text{ times } s & \quad m \text{ times } n & \quad a \text{ times } a \times a
\end{align*}
\]

The numerical factor of a multiplication expression that contains a variable is called a coefficient. So, 6 is the coefficient of \(6d\).

Expressions like \(\frac{y}{2}\) can be written as \(y \div 2\) or \(y \times \frac{1}{2}\).

**Examples**

1. Evaluate \(2(n + 3)\) if \(n = -4\).
   \[
   \begin{align*}
   2(n + 3) &= 2(-4 + 3) \\
   &= 2(-1) \\
   &= -2
   \end{align*}
   \]
   Replace \(n\) with \(-4\). Evaluate inside the parentheses. Multiply.

2. Evaluate \(8w - 2v\) if \(w = 5\) and \(v = 3\).
   \[
   \begin{align*}
   8w - 2v &= 8(5) - 2(3) \\
   &= 40 - 6 \\
   &= 34
   \end{align*}
   \]
   Replace \(w\) with 5 and \(v\) with 3. Do all of the multiplication first. Subtract 6 from 40.

3. Evaluate \(4y^3 + 2\) if \(y = 3\).
   \[
   \begin{align*}
   4y^3 + 2 &= 4(3)^3 + 2 \\
   &= 4(27) + 2 \\
   &= 110
   \end{align*}
   \]
   Replace \(y\) with 3. Evaluate the power. Multiply, then add.

**Got It?** Do these problems to find out.

Evaluate each expression if \(c = 8\) and \(d = -5\).

\[
\begin{align*}
a. \ c - 3 & \quad b. \ 15 - c & \quad c. \ 3(c + d) \\
d. \ 2c - 4d & \quad e. \ d - c^2 & \quad f. \ 2d^2 + 5d
\end{align*}
\]
Example

4. Athletic trainers use the formula \( \frac{3(220 - a)}{5} \), where \( a \) is a person's age, to find their minimum training heart rate. Find Latrina's minimum training heart rate if she is 15 years old.

\[
\frac{3(220 - a)}{5} = \frac{3(220 - 15)}{5} \quad \text{Replace } a \text{ with } 15.
\]

\[
= \frac{3(205)}{5} \quad \text{Subtract } 15 \text{ from } 220.
\]

\[
= \frac{615}{5} \quad \text{Multiply } 3 \text{ and } 205.
\]

\[
= 123 \quad \text{Divide } 615 \text{ by } 5.
\]

Latrina's minimum training heart rate is 123 beats per minute.

Got It? Do this problem to find out.

g. To find the area of a triangle, use the formula \( \frac{bh}{2} \), where \( b \) is the base and \( h \) is the height. What is the area in square inches of a triangle with a height of 6 inches and base of 8 inches?

Write Expressions

To translate a verbal phrase into an algebraic expression, the first step is to define a variable. When you define a variable, you choose a variable to represent an unknown quantity.

Examples

5. Marisa wants to buy a DVD player that costs $150. She already saved $25 and plans to save an additional $10 each week. Write an expression that represents the total amount of money Marisa has saved after any number of weeks.

<table>
<thead>
<tr>
<th>Words</th>
<th>savings of $25 plus ten dollars each week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Let ( w ) represent the number of weeks.</td>
</tr>
<tr>
<td>Expression</td>
<td>25 + 10 ( w )</td>
</tr>
</tbody>
</table>

25 + 10\( w \) represents the total saved after any number of weeks.
6. Refer to Example 5. Will Marisa have saved enough money to buy the $150 DVD player in 11 weeks? Use the expression $25 + 10w$.

\[
25 + 10w = 25 + 10(11) \quad \text{Replace } w \text{ with } 11.
\]

\[
= 25 + 110 \quad \text{Multiply.}
\]

\[
= 135 \quad \text{Add.}
\]

Marisa will have saved $135 after 11 weeks. Since $135 < $150, Marisa will not have enough money to buy the DVD player.

Got It? Do this problem to find out.

h. An MP3 player costs $70 and song downloads cost $0.85 each. Write an expression that represents the cost of the MP3 player and \( x \) number of downloaded songs. Then find the total cost if 20 songs are downloaded.

Guided Practice

Evaluate each expression if \( m = 2, n = 6, \) and \( p = -4 \). (Examples 1–4)

1. \( 3m + 4p \)  
2. \( n^2 + 5 \)  
3. \( 6p^3 \)

4. A Web site charges $0.99 to download a game and a $12.49 membership fee. Write an expression that gives the total cost in dollars to download \( g \) games. Then find the cost of downloading 5 games. (Examples 5 and 6)

5. \( \square \) Building on the Essential Question  Tell whether the statement below is sometimes, always, or never true. Justify your reasoning.

The expressions \( x - 3 \) and \( y - 3 \) represent the same value.

Rate Yourself!

How well do you understand algebraic expressions? Circle the image that applies.

For more help, go online to access a Personal Tutor.
Independent Practice

Evaluate each expression if \( d = 8, \ e = 3, \ f = 4, \) and \( g = -1 \). (Examples 1–3)

1. \( 2(d + 9) \)

2. \( \frac{d}{4} \)

3. \( \frac{ef}{4} \)

4. \( 4f + d \)

5. \( \frac{5d - 25}{5} \)

6. \( d^2 + 7 \)

7. \( \frac{d - 4}{2} \)

8. \( 10(e + 7) \)

9. \( \frac{2g}{2} \)

10. The expression \( 5n + 2 \) can be used to find the total cost in dollars of bowling where \( n \) is the number of games bowled and 2 represents the cost of shoe rental. How much will it cost Vincent to bowl 3 games? (Example 4)

11. MP Reason Abstractly A car rental company’s fees are shown. Suppose you rent a car using Option 2. Write an expression that gives the total cost in dollars for driving \( m \) miles. Then find the cost for driving 150 miles. (Examples 5 and 6)

<table>
<thead>
<tr>
<th>Car Rental Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
</tr>
<tr>
<td>$19.99 per day</td>
</tr>
<tr>
<td>$0.17 per mi</td>
</tr>
</tbody>
</table>

12. Refer to Exercise 11. Suppose you rent a car using Option 1. Write an expression that gives the total cost in dollars to rent a car for \( d \) days and \( m \) miles. Then find the cost for renting a car for 2 days and driving 70 miles. (Examples 5 and 6)
Evaluate each expression if $x = 3.2$, $y = 6.1$, and $z = 0.2$.

13. $x + y - z$ 

14. $14.6 - (x + y + z)$ 

15. $xz + y^2$ 

---

**H.O.T. Problems** Higher Order Thinking

16. **Reason Abstractly** Write an algebraic expression with the variable $x$ that has a value of 3 when evaluated.

17. **Model with Mathematics** Write a real-world problem that can be represented by the expression $5x + 10$.

18. **Persevere with Problems** To find the total number of diagonals for any given polygon, you can use the expression $\frac{n(n - 3)}{2}$, where $n$ is the number of sides of the polygon.

   a. Determine the minimum value that $n$ could be.

   b. Make a table of four possible values of $n$. Then complete the table by evaluating the expression for each value of $n$.

   c. Check by drawing the diagonals of a pentagon and counting the diagonals.

19. **Persevere with Problems** Franco constructed the objects below using toothpicks.

   ![Figure 1](image1)  ![Figure 2](image2)  ![Figure 3](image3)

Write two different rules that relate the figure number to the number of toothpicks in each figure.
Evaluate each expression if \( d = 8, \ e = 3, \ f = 4, \) and \( g = -1. \)

20. \( 10 - e \)
\[ 10 - e \]
\[ 10 - 3 = 7 \]

21. \( \frac{16}{f} \)
\[ \frac{16}{4} \]
\[ \frac{4}{4} = 4 \]

22. \( 4e^2 \)

23. \( 8g - f \)

24. \( \frac{(5 + g)^2}{2} \)

25. \( e^2 - 4 \)

26. The expression \( \frac{w}{30} \), where \( w \) is a person's weight in pounds, is used to find the approximate number of quarts of blood in the person's body. How many quarts of blood does a 120-pound person have?

27. **Model with Mathematics** Refer to the graphic novel frame below. Let \( n \) represent the number of text messages. Evaluate the expression \( 0.15(n - 250) + 5 \) to find the cost of 275 text messages.
28. Tonya has \( x \) quarters, \( y \) dimes, and \( z \) nickels in her pocket. Select the appropriate operations to complete the expression that represents the total amount of change Tonya has in her pocket.

\[
\$0.25 \, x \quad \$0.1 \, y \quad \$0.05 \, z
\]

Evaluate the expression for \( x = 3 \), \( y = 5 \), and \( z = 2 \). What does this value represent?

29. The prices of magazines and books at the school book fair are shown in the table. Determine if each statement is true or false.

<table>
<thead>
<tr>
<th>School Book Fair Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>Magazines</td>
</tr>
<tr>
<td>Paperback books</td>
</tr>
</tbody>
</table>

a. The expression \( 7.95b + 4.95m \) represents the cost of buying \( b \) books and \( m \) magazines.  

\( \square \) True \hspace{1cm} \( \square \) False

b. The expression \( 12.90(b + m) \) represents the cost of buying \( b \) books and \( m \) magazines.  

\( \square \) True \hspace{1cm} \( \square \) False

c. The total cost of buying 3 books and 4 magazines is $43.65.  

\( \square \) True \hspace{1cm} \( \square \) False

Common Core Spiral Review

Define a variable and write each phrase as an algebraic expression. 6.EE.2

30. 8 feet less than the height

31. Sarah worked 8 more hours than Paida.

32. Kumar has twice the number of goals as Jacob.

33. Addison is 3 years younger than Nathan.

34. The table shows the costs of different camping activities. Over the summer, Maura canoed 4 times and fished 3 times. Write and evaluate an expression that represents the total cost Maura spent canoeing and fishing. 5.OA.1

<table>
<thead>
<tr>
<th>Camping Activity Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
</tr>
<tr>
<td>Canoeing</td>
</tr>
<tr>
<td>Fishing</td>
</tr>
</tbody>
</table>

A sequence is an ordered list of numbers. Each number in a sequence is called a term. In an arithmetic sequence, each term is found by adding the same number to the previous term.

Complete the graphic organizer below.

```
Numbers
Continue each sequence.
1, 3, 5, 7, __, ...
1, 1.5, 2, __, __, __, ...

Words
Describe each sequence.
Add __ to the previous term.
```

**Real-World Link**

**Horseback Riding** The number of students who went on each horseback riding trip is shown. Do the numbers represent the terms of an arithmetic sequence? Explain.

<table>
<thead>
<tr>
<th>Trip</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Students</td>
<td>15</td>
<td>16</td>
<td>18</td>
<td>21</td>
<td>25</td>
</tr>
</tbody>
</table>

Which Mathematical Practices did you use? Shade the circle(s) that applies.

1. Persevere with Problems  5. Use Math Tools
2. Reason Abstractly        6. Attend to Precision
3. Construct an Argument    7. Make Use of Structure
4. Model with Mathematics   8. Use Repeated Reasoning
Describe and Extend Sequences

In an arithmetic sequence, the terms can be whole numbers, fractions, or decimals.

**Examples**

1. Describe the relationship between the terms in the arithmetic sequence 8, 13, 18, 23, ... Then write the next three terms in the sequence.

   \[8, 13, 18, 23, \ldots\]

   Each term is found by adding 5 to the previous term.

   Continue the pattern to find the next three terms.

   \[23 + 5 = 28 \quad 28 + 5 = 33 \quad 33 + 5 = 38\]

   The next three terms are 28, 33, and 38.

2. Describe the relationship between the terms in the arithmetic sequence 0.4, 0.6, 0.8, 1.0, ... Then write the next three terms in the sequence.

   \[0.4, 0.6, 0.8, 1.0, \ldots\]

   Each term is found by adding 0.2 to the previous term.

   Continue the pattern to find the next three terms.

   \[1.0 + 0.2 = 1.2 \quad 1.2 + 0.2 = 1.4 \quad 1.4 + 0.2 = 1.5\]

   The next three terms are 1.2, 1.4, and 1.6.

Got It? Do these problems to find out.

Describe the relationship between the terms in each arithmetic sequence. Then write the next three terms in the sequence.

a. 0, 13, 26, 39, ...

b. 4, 7, 10, 13, ...

c. 1.0, 1.3, 1.6, 1.9, ...

d. 2.5, 3.0, 3.5, 4.0, ...
Write an Algebraic Expression

In a sequence, each term has a specific position within the sequence. Consider the sequence 2, 4, 6, 8,...

Notice that as the position number increases by 1, the value of the term increases by 2.

<table>
<thead>
<tr>
<th>Position</th>
<th>Operation</th>
<th>Value of Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 \cdot 1 = 2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2 \cdot 2 = 4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>2 \cdot 3 = 6</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>2 \cdot 4 = 8</td>
<td>8</td>
</tr>
</tbody>
</table>

You can also write an algebraic expression to represent the relationship between any term in a sequence and its position in the sequence. In this case, if \( n \) represents the position in the sequence, the value of the term is \( 2n \).

Example

3. The greeting cards that Meredith makes are sold in boxes at a gift store. The first week, the store sold 5 boxes. Each week, the store sells five more boxes. The pattern continues. What algebraic expression can be used to find the total number of boxes sold at the end of the 100th week? What is the total?

<table>
<thead>
<tr>
<th>Position</th>
<th>Operation</th>
<th>Value of Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 \cdot 5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>2 \cdot 5</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>3 \cdot 5</td>
<td>15</td>
</tr>
<tr>
<td>( n )</td>
<td>( n \cdot 5 )</td>
<td>( 5n )</td>
</tr>
</tbody>
</table>

Each term is 5 times its position. So, the expression is \( 5n \).

\[
5n
\]

Write the expression

\[
5(100) = 500
\]

Replace \( n \) with 100

At the end of 100 weeks, 500 boxes will have been sold.
e. Suppose Figure 1 had 3 circles, Figure 2 had 5 circles, and Figure 3 had 7 circles. What algebraic expression represents this situation?

Guided Practice

Describe the relationship between the terms in each arithmetic sequence. Then write the next three terms in each sequence. (Examples 1 and 2)

1. 0, 9, 18, 27, ...

2. 4, 9, 14, 19, ...

3. 1, 11, 1, 2, 13, ...

4. Hannah has a doll collection. The table shows the total number of dolls in her collection for three years. Suppose this pattern continues. Write an algebraic expression to find the number of dolls in her collection after \( n \) years. How many dolls will Hannah have after 25 years? (Example 3)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Dolls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
</tr>
</tbody>
</table>

5. Building on the Essential Question Explain why the following sequence is considered an arithmetic sequence.

\[ 5, 7, 13, 17, 21, \ldots \]
Independent Practice

Describe the relationship between the terms in each arithmetic sequence. Then write the next three terms in each sequence. *(Examples 1 and 2)*

1. 0, 7, 14, 21, ...
   - 
   - 

2. 1, 7, 13, 19, ...
   - 
   - 

3. 26, 34, 42, 50, ...
   - 
   - 

4. 0.1, 0.4, 0.7, 1.0, ...
   - 
   - 

5. 2.4, 3.2, 4.0, 4.8, ...
   - 
   - 

6. 2.0, 3.1, 4.2, 5.3, ...
   - 
   - 

7. Refer to the table shown. If the pattern continues, what algebraic expression can be used to find the plant’s height for any month? What will be the plant’s height at 12 months? *(Example 3)*

<table>
<thead>
<tr>
<th>Month</th>
<th>Height (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

8. **Model with Mathematics** Explain how the number of text messages Dario sent and the cost form an arithmetic sequence. Then write an expression to find Dario’s text messaging bill if he sends \( n \) text messages over 250.

   - 
   - 

---

Let’s go back online and try to find a rule so he will know how much his bill will be.

His mom will thank us.

Remember my texting fiasco? How can I know what my bill will be each month?
9. **Multiple Representations** Kendra is stacking boxes of tissues for a store display. She stacks 3 boxes in the first minute, 6 boxes by the end of the second minute, and 9 boxes by the end of the third minute. Suppose the pattern continues for parts a–d.

a. **Table** Make a table of values for 1, 2, 3, 4, and 5 minutes.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

b. **Symbols** Write an expression to find the $n$th term in the sequence.

$c. **Graph** Graph the table of values from part a on the coordinate plane. Let $x$ represent the number of minutes and $y$ represent the number of boxes. Then describe the graph.


d. **Numbers** How many boxes will be displayed after 45 minutes?

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**H.O.T. Problems** Higher Order Thinking

10. **MP Justify Conclusions** Write five terms of an arithmetic sequence and describe the rule for finding the terms.

11. **Persevere with Problems** Not all sequences are arithmetic. But, there is still a pattern. Describe the relationship between the terms in each sequence. Then write the next three terms in the sequence.

11. 1, 2, 4, 7, 11, ...

12. 0, 2, 6, 12, 20, ...

13. **Persevere with Problems** Use an arithmetic sequence to find the number of multiples of 6 between 41 and 523. Justify your reasoning.
Describe the relationship between the terms in each arithmetic sequence. Then write the next three terms in each sequence.

14. 19, 31, 43, 55, ...
   12 is added to the previous term; 67, 79, 91

15. 6, 16, 26, 36, ...
   10 is added to the previous term; 46, 56, 66

16. 33, 38, 43, 48, ...

17. 4.5, 6.0, 7.5, 9.0, ...

18. 1.2, 3.2, 5.2, 7.2, ...

19. 4.6, 8.6, 12.5, 16.6, ...

20. 18, 33, 48, 63, ...

21. 20, 45, 70, 95, ...

22. 38, 61, 84, 107, ...

23. **Reason Abstractly** Refer to the figures for parts a and b.

   a. Describe the relationship between the figures and the number of rectangles shown.

   b. If the pattern continues, how many rectangles will be in the next 2 figures?

   The terms of an arithmetic sequence can be related by subtraction. Write the next three terms of each sequence.

24. 32, 27, 22, 17, ...

25. 45, 42, 39, 36, ...

26. 10.5, 10, 9.5, 9, ...

Lesson 2 Sequences 363
27. The table shows the first 5 terms of a sequence. Determine if each statement is true or false.

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>n</th>
<th>Value of Term</th>
<th>2</th>
<th>5</th>
<th>10</th>
<th>17</th>
<th>26</th>
</tr>
</thead>
</table>

a. The expression \( n^2 + 1 \) can be used to find the \( n \)th term of the sequence.  [ ] True [ ] False

b. The 8th term of the sequence is 65.  [ ] True [ ] False

c. The table represents an arithmetic sequence.  [ ] True [ ] False

28. Katie is putting photos in an album. She puts five pictures on the first page. Each page after that contains five pictures. Suppose the pattern continues. Complete the table of values for 1, 2, 3, 4, and 5 pages. Then graph the table of values on the coordinate plane. Let \( x \) represent the number of pages and \( y \) represent the total number of photos.

<table>
<thead>
<tr>
<th>Number of Pages</th>
<th>Total Photos</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

How many photos will Katie have on 20 pages?

Common Core Spiral Review

Evaluate. \( \text{6.EE.1} \)

29. \( 1^4 = \) 
30. \( 3^3 = \) 
31. \( 8^2 = \) 
32. \( 10^4 = \) 
33. \( 5^1 = \) 
34. \( 7^5 = \) 

35. Jayden goes to the batting cage. He purchases three tokens and rents a helmet. If he spends a total of $6.50, how much is each token? \( \text{6.EE.5} \)

Batting Cage Prices

<table>
<thead>
<tr>
<th>Tokens</th>
<th>Helmet Rental</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$2</td>
</tr>
</tbody>
</table>

Need more practice? Download more Extra Practice at connectED.mcgraw-hill.com.
**Inquiry Lab**

**Sequences**

**Inquiry**

How can geometric figures be used to model numerical patterns?

A fencing company uses 4 planks of wood for one section of fencing, 7 planks for two sections, and 10 planks of wood for three sections. The fence sections are represented using the toothpicks shown. Determine how many planks would be used to create 5 sections of fencing.

![Diagram of fence sections]

**Hands-On Activity**

**Step 1** Find a pattern in the table. Then fill in the number of planks that would be in 4 and 5 sections of fencing.

<table>
<thead>
<tr>
<th>Number of Sections</th>
<th>Number of Planks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

**Step 2** Check your work by using toothpicks to show 5 fence sections. Draw the result in the space below.

So, there will be [ ] planks in 5 sections of fencing.
Investigate

Work with a partner. Complete the table. You can use toothpicks to continue each pattern if needed.

1.

<table>
<thead>
<tr>
<th>Figure Number</th>
<th>Number of Toothpicks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

2. Refer to Exercise 1. Write an expression that could be used to find the number of toothpicks that would be needed for any figure.

3. Use your expression from Exercise 2 to find the number of toothpicks that would be needed to create Figure 10. Explain.

Create

4. **MP Reason Abstractly** Refer to the activity. Write an expression that could be used to find the number of planks in any number of sections.

5. **MP Justify Conclusions** Use the expression in Exercise 4 to find the number of planks that would be needed to create 10 sections of fencing. Explain.

6. **Inquiry** HOW can geometric figures be used to model numerical patterns?
Real-World Link

Driving Miss Ricardo drives up and down her street to complete different errands. Some of the places on her street are shown below. The number of blocks between the places are also shown.

1. Suppose Miss Ricardo drives from home to the game store and back. Write an expression for each distance.
   - from home to the game store:
   - from the game store to home:

2. Circle the property that is illustrated in Exercise 1.
   - Commutative
   - Associative

3. On Monday, Miss Ricardo drives from home, stops at the library, and then drives to the football field. On Tuesday, she drives from home, stops at the game store, and then drives to the football field. Write an expression for each distance.
   - Monday:
   - Tuesday:

4. Circle the property that is illustrated in Exercise 3.
   - Commutative
   - Associative

Which Mathematical Practices did you use?
Shade the circle(s) that applies.

1. Persevere with Problems
2. Reason Abstractly
3. Construct an Argument
4. Model with Mathematics
5. Use Math Tools
6. Attend to Precision
7. Make Use of Structure
8. Use Repeated Reasoning
## Properties of Operations

### Words
The **Commutative Property** states that the order in which numbers are added or multiplied does not change the sum or product.

<table>
<thead>
<tr>
<th>Addition</th>
<th>Multiplication</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a + b = b + a )</td>
<td>( a \cdot b = b \cdot a )</td>
</tr>
</tbody>
</table>

### Symbols
- \( a + b = b + a \)
- \( 6 + 1 = 1 + 6 \)
- \( a \cdot b = b \cdot a \)
- \( 7 \cdot 3 = 3 \cdot 7 \)

### Words
The **Associative Property** states that the way in which numbers are grouped when they are added or multiplied does not change the sum or product.

<table>
<thead>
<tr>
<th>Addition</th>
<th>Multiplication</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a + (b + c) = (a + b) + c )</td>
<td>( a \cdot (b \cdot c) = (a \cdot b) \cdot c )</td>
</tr>
</tbody>
</table>

### Examples
- \( a + (b + c) = (a + b) + c \)
- \( 2 + (3 + 8) = (2 + 3) + 8 \)
- \( a \cdot (b \cdot c) = (a \cdot b) \cdot c \)
- \( 3 \cdot (4 \cdot 5) = (3 \cdot 4) \cdot 5 \)

### A property
A property is a statement that is true for any number. The following properties are also true for any numbers.

<table>
<thead>
<tr>
<th>Property</th>
<th>Words</th>
<th>Symbols</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Additive Identity</strong></td>
<td>When 0 is added to any number, the sum is the number.</td>
<td>( a + 0 = a )</td>
<td>( 9 + 0 = 9 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( 0 + a = a )</td>
<td>( 0 - 9 = 9 )</td>
</tr>
<tr>
<td><strong>Multiplicative Identity</strong></td>
<td>When any number is multiplied by 1, the product is the number.</td>
<td>( a \cdot 1 = a )</td>
<td>( 5 \cdot 1 = 5 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( 1 \cdot a = a )</td>
<td>( 1 \cdot 5 = 5 )</td>
</tr>
<tr>
<td><strong>Multiplicative Property of Zero</strong></td>
<td>When any number is multiplied by 0, the product is 0.</td>
<td>( a \cdot 0 = 0 )</td>
<td>( 8 \cdot 0 = 0 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( 0 \cdot a = 0 )</td>
<td>( 0 \cdot 8 = 0 )</td>
</tr>
</tbody>
</table>

### Example

1. Name the property shown by the statement
   \[ 2 \cdot (5 \cdot n) = (2 \cdot 5) \cdot n. \]
   The order of the numbers and variable did not change, but their grouping did. This is the **Associative Property of Multiplication**.

### Got It? Do these problems to find out.

#### a.
\[ 42 + x + y = 42 + y + x \]

#### b.
\[ 3x + 0 = 3x \]
You may wonder if any of the properties apply to subtraction or division. If you can find a **counterexample**, an example that shows that a conjecture is false, the property does not apply.

**Example**

2. State whether the following conjecture is **true** or **false**. If **false**, provide a counterexample.

   **Division of whole numbers is commutative.**

Write two division expressions using the Commutative Property.

\[
15 \div 3 = 3 + 15 \quad \text{State the conjecture.}
\]

\[
5 \neq \frac{1}{5} \quad \text{Divide}
\]

The conjecture is false. We found a counterexample. That is, 
\[15 \div 3 \neq 3 + 15\]. So, division is **not** commutative.

**Got It?** Do this problem to find out.

   c. The difference of two different whole numbers is always less than both of the two numbers.

**Example**

3. Alana wants to buy a sweater that costs $38, sunglasses that costs $14, a pair of jeans that costs $22, and a T-shirt that costs $16. Use mental math to find the total cost before tax.

Write an expression for the total cost. You can rearrange the numbers using the properties of math. Look for sums that are multiples of ten.

\[
38 + 14 + 22 + 16 \quad \text{Commutative Property of Addition}
\]

\[
= 38 + 22 + 14 + 16 \quad \text{Associative Property of Addition}
\]

\[
= 60 + 30 \quad \text{Add.}
\]

\[
= 90 \quad \text{Simplify.}
\]

The total cost of the items is $90.

**Got It?** Do this problem to find out.

d. Lance made four phone calls from his cell phone today. The calls lasted 4.7, 9.4, 2.3, and 10.6 minutes. Use mental math to find the total amount of time he spent on the phone.
Examples

Simplify each expression. Justify each step.

4. \((7 + g) + 5\)
   \[(7 + g) + 5 = (g + 7) + 5\]
   \[= g + (7 + 5)\]
   \[= g + 12\]  
   Commutative Property of Addition
   Associative Property of Addition
   Simplify.

5. \((m \cdot 11) \cdot m\)
   \[(m \cdot 11) \cdot m = (11 \cdot m) \cdot m\]
   \[= 11 \cdot (m \cdot m)\]
   \[= 11m^2\]  
   Commutative Property of Multiplication
   Associative Property of Multiplication
   Simplify.

Got It? Do this problem to find out.

e. \(4 \cdot (3c \cdot 2)\)

Guided Practice

Name the property shown by each statement. (Example 1)

1. \(3m \cdot 0 \cdot 5m = 0\)
2. \(7c + 0 = 7c\)

3. State whether the following conjecture is true or false. If false, provide a counterexample. (Example 2)
   
   Subtraction of whole numbers is associative.

4. Simplify \(9c + (8 + 3c)\). Justify each step. (Examples 3–5)

5. Building on the Essential Question Explain the difference between the Commutative and Associative Properties.

Rate Yourself!

Are you ready to move on? Shade the section that applies.

YES  ?  NO

For more help, go online to access a Personal Tutor.
Name the property shown by each statement. (Example 1)

1. \( a + (b + 12) = (b + 12) + a \)

2. \( (5 + x) + 0 = 5 + x \)

3. \( 16 + (c + 17) = (16 + c) + 17 \)

4. \( a \cdot 0 = 0 \)

5. **Use a Counterexample** State whether the conjecture is true or false. If false, provide a counterexample. (Example 2)

   *Division of whole numbers is associative.*

6. Darien ordered a soda for $2.75, a sandwich for $8.50, and a dessert for $3.85. Sales tax was $1.15. Use mental math to find the total amount of the bill. Explain. (Example 3)

Simplify each expression. Justify each step. (Examples 4 and 5)

7. \( 15 + (12 + 8a) \)

8. \( (5n + 9) \cdot 2n \)

9. \( 3x \cdot (7 \cdot x) \)

10. \( (4m \cdot 2) \cdot 5m \)
11. Simplify the expression \((7 + 47 + 3)(5 - (2 - 3))\). Use properties to justify each step.

---

**H.O.T. Problems**  
**Higher Order Thinking**

12. **MP Model with Mathematics** Write about something you do every day that is commutative. Then write about another situation that is not commutative.

---

13. **MP Find the Error** Blake is simplifying \(4 \cdot (5 \cdot m)\). Find his mistake and correct it.

\[4 \cdot (5 \cdot m) = 20 \cdot 5m = 100m\]

---

14. **MP Identify Structure** Does the Associative Property always, sometimes, or never hold for subtraction? Explain your reasoning using examples and counterexamples.

---

15. **MP Persevere with Problems** If you take any two whole numbers and add them together, the sum is always a whole number. This is the Closure Property for Addition. The set of whole numbers is closed under addition.
   
   a. Is the set of whole numbers closed under subtraction? If not, give a counterexample.

   b. Suppose you had a very small set of numbers that contained only 0 and 1. Would this set be closed under addition? If not, give a counterexample.
Name the property shown by each statement.

16. \(9(ab) = (9a)b\)
   \(\text{Associative (X)}\)

17. \(y \cdot 7 = 7y\)

18. \(1 \times c = c\)

19. \(5 + (a + b) = (5 + a) + b\)

20. State whether the conjecture is true or false. If false, provide a counterexample.

   \(\text{Subtraction of whole numbers is commutative.}\)

21. **Use Math Tools** The times for each leg of a relay for four runners are shown. Use mental math to find the total time for the relay team. Explain.

<table>
<thead>
<tr>
<th>Runner</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamal</td>
<td>12.4</td>
</tr>
<tr>
<td>Kenneth</td>
<td>11.8</td>
</tr>
<tr>
<td>Bryce</td>
<td>11.2</td>
</tr>
<tr>
<td>Jorge</td>
<td>12.6</td>
</tr>
</tbody>
</table>

Simplify each expression. Justify each step.

22. \((22 + 19b) + 7\)

23. \(18 + (5 + 6m)\)

24. \(11s(4)\)

25. \(10y(7)\)

26. \((9 + 31 + 5) + (7 \cdot 5) \cdot 4\)
27. The table shows the cost of different items at a bakery. Yolanda buys 2 doughnuts, a muffin, and 2 cookies. Which of the following expressions represents the total cost? Select all that apply.

- 2(2.29) + 2(2.21) + 2.50
- 2(2.29) + 2.50 + 2(2.21)
- 2(2.29 + 2.21 + 2.50)
- 2.50 + 2(2.21 + 2.29)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cookie</td>
<td>2.21</td>
</tr>
<tr>
<td>Doughnut</td>
<td>2.29</td>
</tr>
<tr>
<td>Muffin</td>
<td>2.50</td>
</tr>
<tr>
<td>Roll</td>
<td>1.15</td>
</tr>
</tbody>
</table>

28. Determine if the two expressions in each pair are equivalent. If they are equivalent, select the property that is illustrated.

<table>
<thead>
<tr>
<th>Equivalent?</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 • 4 ÷ 20 = 9 • 20 ÷ 4</td>
<td></td>
</tr>
<tr>
<td>3b • 0 • c = 0</td>
<td></td>
</tr>
<tr>
<td>35 + 2m + n = 35 + n + 2m</td>
<td></td>
</tr>
<tr>
<td>12r • 3v + 0 = 12r • 3v</td>
<td></td>
</tr>
</tbody>
</table>

**Commutative Property**

**Identity Property**

**Associative Property**

**Multiplicative Property of Zero**

---

**Common Core Spiral Review**

Evaluate each expression if \( a = 6, b = 15, \) and \( c = 9.\) \(6.EE.2\)

29. \( a + 2b \)

30. \( c^2 - 5 \)

31. \( 10 + a^3 \)

32. \( 8c - 9 + 25 \)

33. \( 14 + 8b + 2 \)

34. \( 3^3 + (3a) \)

35. A package of pencils costs $1.25. A new eraser costs $0.45.
   Write an expression to find the total cost of 3 packages of pencils and 2 erasers. Then find the total cost. \(6.EE.2\)
School Supplies  Jordan buys three notebooks that cost $5 each. He also buys three packages of pens for $6 each.

1. Write an expression that shows the cost of three notebooks added to the cost of three packages of pens.
   \[ 5 + 6 \]

2. Write an expression that shows three times the cost of one notebook and one package of pens.
   \[ ( + ) \]

3. Evaluate both expressions. What do you notice?

4. Suppose Jordan buys five notebooks that cost $3 each and five packages of pens that cost $1 each. Circle the expressions that represent Jordan’s purchases.
   \[ 5 \cdot 3 + 5 \cdot 1 \quad 5 \cdot 3 \cdot 5 \cdot 1 \quad 5(3 + 1) \]

5. Suppose Jordan buys two rulers that cost $1 each and two folders that cost $1.50 each. Circle the expressions that represent Jordan’s purchases.
   \[ 2 + 1 + 2 + 1.50 \quad 2(1 + 1.50) \quad 2 \cdot 1 + 2 \cdot 1.50 \]

Which Mathematical Practices did you use? Shade the circle(s) that applies.

1. Persevere with Problems
2. Reason Abstractly
3. Construct an Argument
4. Model with Mathematics
5. Use Math Tools
6. Attend to Precision
7. Make Use of Structure
8. Use Repeated Reasoning
Key Concept

**Use the Distributive Property**

**Words**  The **Distributive Property** states that to multiply a sum or difference by a number, multiply each term inside the parentheses by the number outside the parentheses.

**Symbols**  \(a(b + c) = ab + ac\)  \(a(b - c) = ab - ac\)

**Examples**  
4\((6 + 2)\) = 4 \(\cdot 6 + 4 \cdot 2\)  
3\((7 - 5)\) = 3 \(\cdot 7 - 3 \cdot 5\)

You can model the Distributive Property with algebraic expressions using algebra tiles. The expression 2\((x + 2)\) is modeled below.

Model \(x + 2\) using algebra tiles.

Double the amount of tiles to represent 2\((x + 2)\).

Rearrange the tiles by grouping together the ones with the same shapes.

\[2(x + 2) = 2(x) + 2(2)\]  
Distributive Property

= 2x + 4  
Multiply.

The expressions 2\((x + 2)\) and 2x + 4 are equivalent expressions. No matter what x is, these expressions have the same value.

**Example**

1. **Use the Distributive Property to evaluate 8(\(-9 + 4)\).**

\[8(\(-9 + 4)\) = 8(\(-9\)) + 8(4)\]  
Expand using the Distributive Property.

= \(-72 + 32\) or \(-40\)  
Multiply. Then add.

**Got It? Do these problems to find out.**

a. \(5(\(-9 + 11)\)  
b. \(7(10 - 5)\)  
c. \((12 - 8)9\)
Examples

Use the Distributive Property to rewrite each expression.

2. \( 4(x + 7) \)
\[
4(x + 7) = 4(x) + 4(7)
\]
Expand using the Distributive Property.
\[
= 4x + 28
\]
Simplify.

3. \( 6(p - 5) \)
\[
6(p - 5) = 6(p + (-5))
\]
Rewrite \( p - 5 \) as \( p + (-5) \).
\[
= 6p + 6(-5)
\]
Expand using the Distributive Property.
\[
= 6p + (-30)
\]
Simplify.
\[
= 6p - 30
\]
Definition of subtraction.

4. \( -2(x - 8) \)
\[
-2(x - 8) = -2[x + (-8)]
\]
Rewrite \( x - 8 \) as \( x + (-8) \).
\[
= -2(x) + -2(-8)
\]
Expand using the Distributive Property.
\[
= -2x + 16
\]
Simplify.

5. \( 5(-3x + 7y) \)
\[
5(-3x + 7y) = 5(-3x) + 5(7y)
\]
Expand using the Distributive Property.
\[
= -15x + 35y
\]
Simplify.

6. \( \frac{1}{3}(x - 6) \)
\[
\frac{1}{3}(x - 6) = \frac{1}{3}[x + (-6)]
\]
Rewrite \( x - 6 \) as \( x + (-6) \).
\[
= \frac{1}{3}(x) + \frac{1}{3}(-6)
\]
Expand using the Distributive Property.
\[
= \frac{1}{3}x + (-2)
\]
Simplify.
\[
= \frac{1}{3}x - 2
\]
Definition of subtraction.

Got It? Do these problems to find out.

d. \( 6(\alpha + 4) \)
e. \( (m + 3n)8 \)
f. \( -3(y - 10) \)
g. \( \frac{1}{2}(w - 4) \)
Example

7. Mr. Ito needs to buy batting helmets for the baseball team. The helmets he plans to buy are $19.95 each. Find the total cost if Mr. Ito needs to buy 9 batting helmets for the team.

Rename $19.95 as $20.00 − $0.05. Then use the Distributive Property to find the total cost mentally.

\[ 9(20.00 - 0.05) = 9(20.00) - 9(0.05) \]

\[ = 180 - 0.45 \]

\[ = 179.55 \]

The total cost of the helmets is $179.55.

Got it? Do this problem to find out.

h. A sports club rents dirt bikes for $37.50 each. Find the total cost for the club to rent 20 bikes. Justify your answer by using the Distributive Property.

Guided Practice

Use the Distributive Property to evaluate or rewrite each expression. (Examples 1–6)

1. \((8 + 11)(-3) =\)

2. \(-5(2x + 4y) =\)

3. \(\frac{1}{5}(g - 10) =\)

4. A housefly can fly about 6.4 feet per second. At this rate, how far can it fly in 25 seconds? Justify your answer by using the Distributive Property. (Example 7)

5. Building on the Essential Question Describe how the formula to find the perimeter of a rectangle is an application of the Distributive Property.

Rate Yourself!

How confident are you about the Distributive Property? Check the box that applies.

For more help, go online to access a Personal Tutor.
Use the Distributive Property to evaluate each expression.  (Example 1)

1. \(3(5 + 6) = \) 
2. \((6 + 4)(-12) = \)
3. \(-6(9 - 4) = \)

4. \(5(-6 + 4) = \)
5. \(4(8 - 7) = \)
6. \((5 - 7)(-3) = \)

Identify Structure  Use the Distributive Property to rewrite each expression.  (Examples 2-6)

7. \(3(-4x + 8) = \)
8. \(4(x - 6y) = \)
9. \(6(5 - q) = \)

10. \(\frac{1}{2}(c - 8) = \)
11. \(-3(5 - b) = \)
12. \((d + 2)(-7) = \)

13. Amelia bought roast beef for $6.85 per pound. Find the total cost if Amelia bought 4 pounds of roast beef. Justify your answer by using the Distributive Property.  (Example 7)

14. The table shows the different prices of items at a movie theater.
   a. Suppose Mina and two of her friends go to the movies. Write an expression that could be used to find the total cost for them to go to the movies and buy one of each item.

   b. What is the total cost for all three people?
Use Math Tools Find each product mentally. Justify your answer.

15. $9 \cdot 35 =$

16. $8 \cdot 28 =$

17. $112 \cdot 6 =$

18. $85 \cdot 8 =$

19. $4 \cdot 122 =$

20. $12 \cdot 64 =$

H.O.T. Problems Higher Order Thinking

21. **Reason Abstractly** Write an expression that when using the Distributive Property can be simplified to $12a + 18b - 6c$.

22. **Identify Structure** Use the Distributive Property to rewrite the expression $7bx + 7by$ as an equivalent expression.

23. **Persevere with Problems** Use the Distributive Property to write an equivalent expression for the expression $(a + b)(2 + y)$.

24. **Find the Error** Julia is using the Distributive Property to simplify $3(x + 2)$. Find her mistake and correct it.

\[3(x + 2) = 3x + 2\]

25. **Persevere with Problems** Is $3 + (x \cdot y) = (3 + x) \cdot (3 + y)$ a true statement? If so, explain your reasoning. If not, give a counterexample.
Extra Practice

Use the Distributive Property to evaluate each expression.

26. \((3 + 6)(-8) = \) \(-72\)

27. \(4(11 - 5) = \)

28. \((12 - 4)(-5) = \)

\[3 \cdot (-8) + 6 \cdot (-8) = \]

\[-24 + (-48) = -72\]

Use the Distributive Property to rewrite each expression.

29. \(-8(a + b) = \)

30. \((2b + 8)5 = \)

31. \((p + 7)(-2) = \)

32. **Justify Conclusions** Theresa is planning on making a fleece blanket for her nephew. She learns that the fabric she wants to use is $7.99 per yard. Find the total cost of 4 yards of fabric. Justify your answer by using the Distributive Property.

33. You are ordering T-shirts with your school's mascot printed on them. Each T-shirt costs $4.75. The printer charges a setup fee of $30 and $2.50 to print each shirt. Write two expressions to represent the total cost of printing \(n\) T-shirts.

Use the Distributive Property to rewrite each expression.

34. \(0.5(x - z) = \)

35. \(-6a(2b + 5c) = \)

36. \(-4m(3n - 6p) = \)

37. \(3(2y + 4z) = \)

38. \(-2(3a - 2b) = \)

39. \(-6(12p - 8n) = \)

40. Write two equivalent expressions for the area of the figure.
41. A group of 3 seniors, 3 adults, and 3 children bought tickets to the aquarium.

Fill in the boxes to model the total amount spent with an expression.

\[ \underline{ \text{ }} \times (\underline{ \text{ }} + \underline{ \text{ }} + \underline{ \text{ }} )\]

How much did the group spend on tickets altogether? How does applying the Distributive Property make it easier to find this amount?

<table>
<thead>
<tr>
<th>Type of Ticket</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>18.95</td>
</tr>
<tr>
<td>Senior</td>
<td>14.95</td>
</tr>
<tr>
<td>Child</td>
<td>9.95</td>
</tr>
</tbody>
</table>

42. Celeste is going to summer camp. The table shows the cost of items she will need to purchase with the camp logo. She needs to buy four of each item.

Which of the following expressions represents the total cost of the items? Select all that apply.

- 4(14.75)
- 4(8.00) + 4.50 + 2.25
- 4(8) + 4(4.50) + 4(2.25)
- 4(8.00 + 4.50 + 2.25)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-shirt</td>
<td>8.00</td>
</tr>
<tr>
<td>Shorts</td>
<td>4.50</td>
</tr>
<tr>
<td>Socks</td>
<td>2.25</td>
</tr>
</tbody>
</table>

**Common Core Spiral Review**

Evaluate each expression if \( x = 9 \) and \( y = 3 \). \( \textit{6.EE.2c} \)

43. \( x + y - 58 \)  
44. \( y^3 + x^3 \)  
45. \( y^4 - 128 \) = 

46. In the expression below, identify the coefficient and the variable. \( \textit{6.EE.2} \)

\[ 4x + 450 \]

coefficient: __________ variable: __________

Need more practice? Download more Extra Practice at connectED.mcgraw-hill.com.
Case #1 Mountain Biking
Hoshi wants to purchase a membership to a bike park. The cost depends on the number of people on the membership. It costs $55 for 5 people, $65 for 6 people, and $75 for 7 people.
Find the cost of a membership that includes 8 people.

Understand  What are the facts?
The cost of a membership depends on the number of people included on the membership.

Plan  What is your strategy to solve this problem?
Make a table that shows the number of people and the cost.

Solve  How can you apply the strategy?
Make a table. Find the cost for 8 people.

<table>
<thead>
<tr>
<th>Number of People (p)</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>$55</td>
</tr>
<tr>
<td>6</td>
<td>$65</td>
</tr>
<tr>
<td>7</td>
<td>$75</td>
</tr>
</tbody>
</table>

So, the cost for 8 people is

Check  Does the answer make sense?
The expression $10p + 5$ can be used to represent the situation.
Since $10(8) + 5 = 85$, the solution is reasonable.

Analyze the Strategy

MP Justify Conclusions  Hoshi wants to purchase a membership for four people. Explain how the table would change and then solve.
Case #2 Financial Literacy

Latoya is saving money to buy a saxophone. After 1 month, she has $75. After 2 months, she has $120. After 3 months, she has $165. She plans to keep saving at the same rate.

How long will it take Latoya to save enough money to buy a saxophone that costs $300?

1

Understand

Read the problem. What are you being asked to find?

I need to find

Underline key words and values. What information do you know?

After 1 month, Latoya has ___. After 2 months, she has ___.
After 3 months, she has ___. She continues to save at the same rate.

Is there any information that you do not need to know?

I do not need to know

2

Plan

Choose a problem-solving strategy.

I will use the _____ strategy.

3

Solve

Use your problem-solving strategy to solve the problem.

<table>
<thead>
<tr>
<th>Months</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Saved ($)</td>
<td>75</td>
<td>120</td>
<td>165</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Latoya will have $300 saved in ___.

4

Check

Use information from the problem to check your answer.

384 Chapter 5 Expressions
Work with a small group to solve the following cases. Show your work on a separate piece of paper.

**Case #3  Carnivals**
For a carnival game, containers are arranged in a triangular display. The top row has 1 container. The second row has 2 containers. The third row has 3 containers. The pattern continues until the bottom row, which has 10 containers.

A contestant knocks down 29 containers on the first throw. How many containers remain?

**Case #4  Budget**
Tamara earns $2,050 each month. She spends 65% of the amount she earns. The rest of the money is equally divided and deposited into two separate accounts.

How many months until Tamara has deposited more than $2,500 in one of her accounts?

**Case #5  Toothpicks**
Write an expression that can be used to find the number of toothpicks needed to make any figure. Then find the number of toothpicks needed to make the eighth figure.

**Figure 1**

**Figure 2**

**Figure 3**

**Case #6  Diving**
A diver descends to $-15$ feet after 1 minute, $-30$ feet after 2 minutes, and $-45$ feet after 3 minutes.

If the diver keeps descending at this rate, what is their position after 12 minutes?
Vocabulary Check

1. Fill in the blank in the sentence below with the correct term. (Lesson 1)
   A __________________________ is a symbol that represents an unknown quantity.

2. Define arithmetic sequence. Then provide an example. (Lesson 2)

Skills Check and Problem Solving

Describe the relationship between the terms in each arithmetic sequence. Then write the next three terms in each sequence. (Lesson 2)

3. 5, 8, 11, 14, ...

4. 4, 11, 18, 25, ...

5. 5.8, 10.8, 15.8, 20.8, ...

Use the Distributive Property to rewrite each expression. (Lesson 4)

6. 4(x + 9) = __________

7. 2(x + 5) = __________

8. 3(−2x + 4) = __________

9. **MP Identify Structure** What property is shown by the statement $8x + 0 = 8x$? (Lesson 3)

10. **MP Persevere with Problems** A coach bought some baseball bats and five baseball gloves. Let $b$ represent the number of bats. Write an expression that can be used to find the total cost of the bats and gloves. Then find the total cost if he bought three bats. (Lesson 1)
Music Store  Patricia, Hugo, and Sun work at a music store. Each week, Patricia works three more than twice the number of hours that Hugo works. Sun works 2 less hours than Hugo.

1. Let \( x \) represent the number of hours that Hugo works each week. The number of hours that Hugo, Patricia, and Sun work can be modeled as shown below. Write an expression that represents each person's number of hours.

**Hugo's hours:** \( x \)

**Patricia's hours:** 
- Twice Hugo: \( x \times 2 \) 
- Three more: \( x + 3 \)

**Sun's hours:** 
- Hugo Two less: \( x - 2 \)

Expression: \( \)  Expression: \( \)  Expression: \( \)

2. Model the total number of hours that Patricia and Sun work. Draw the result below. Then write an expression for the drawing.

Expression: 

3. Like tiles are tiles that have the same shape. Group like tiles together and remove the zero pairs. Draw the result below. Then write an expression for your drawing.

Expression: 

---

Which **MP Mathematical Practices** did you use?  
Shade the circle(s) that applies.

- **1. Persevere with Problems**  
- **2. Reason Abstractly**  
- **3. Construct an Argument**  
- **4. Model with Mathematics**  
- **5. Use Math Tools**  
- **6. Attend to Precision**  
- **7. Make Use of Structure**  
- **8. Use Repeated Reasoning**
Identify Parts of an Expression

When addition or subtraction signs separate an algebraic expression into parts, each part is called a term. Recall that the numerical factor of a term that contains a variable is called the coefficient of the variable.

Like terms contain the same variables to the same powers. For example, $3x^2$ and $-7x^2$ are like terms. So are $8xy^2$ and $12xy^2$. But $10x^2z$ and $22xz^2$ are not like terms. A term without a variable is called a constant. Constant terms are also like terms.

Example

1. Identify the terms, like terms, coefficients, and constants in the expression $6n - 7n - 4 + n$.

   $6n - 7n - 4 + n = 6n + (-7n) + (-4) + 1n$  Rewrite the expression.

   - Terms: $6n, -7n, -4, n$
   - Like terms: $6n, -7n, n$  All of these terms have the same variable.
   - Coefficients: 6, $-7, 1$
   - Constants: $-4$  This is the only term without a variable.

Got It? Do these problems to find out.

Identify the terms, like terms, coefficients, and constants in each expression.

a. $9y - 4 - 11y + 7$

b. $3x + 2 - 10 - 3x$

Simplify Algebraic Expressions

An algebraic expression is in simplest form if it has no like terms and no parentheses. Use the Distributive Property to combine like terms.
Examples

2. Write $4y + y$ in simplest form.

$4y$ and $y$ are like terms.
$4y + y = 4y + 1y$  
Identity Property; $y = 1y$
$= (4 + 1)y$ or $5y$  
Distributive Property; Simplify

3. Write $7x - 2 - 7x + 6$ in simplest form.

$7x$ and $-7x$ are like terms. $-2$ and $6$ are also like terms.
$7x - 2 - 7x + 6 = 7x + (-2) + (-7x) + 6$  
Definition of subtraction
$= 7x + (-7x) + (-2) + 6$  
Commutative Property
$= (7 + (-7))x + (-2) + 6$  
Distributive Property
$= 0x + 4$  
Simplify
$= 0 + 4$ or $4$  
Multiplicative Property of zero and Additive Identity Property of zero.

Got It? Do these problems to find out.

(c) $4z - z$
(d) $6 - 3n + 3n$
(e) $2g - 3 + 11 - 8g$

Example

4. The cost of a jacket $j$ after a 5% markup can be represented by the expression $j + 0.05j$. Simplify the expression. Then determine the total cost of the jacket after the markup, if the original price is $35.

$j + 0.05j = 1j + 0.05j$  
Identity Property; $j = 1j$
$= (1 + 0.05)j$  
Distributive Property
$= 1.05j$  
Simplify
$1.05j = 1.05(35)$  
Replace $j$ with 35 to find the total cost.
$= 36.75$  
Multiply

So, the cost of the jacket after a 5% markup is $36.75.

Got It? Do this problem to find out.

(f) Write an expression in simplest form for the cost of the jacket in Example 4 if the markup is 8%. Then determine the total cost after the markup.
Example

5. At a concert, you buy some T-shirts for $12.00 each and the same number of CDs for $7.50 each. Write an expression in simplest form that represents the total amount spent.

Let \( x \) represent the number of T-shirts and CDs.

\[
12x + 7.50x
\]

Write the expression.

\[
12x + 7.50x = (12 + 7.50)x
\]

Distributive Property

\[
= 19.50x
\]

Simplify.

The expression $19.50x$ represents the total amount spent.

Got It? Do this problem to find out.

g. You have some money. Your friend has $50 less than you. Write an expression in simplest form that represents the total amount of money you and your friend have.

Guided Practice

1. Identify the terms, like terms, coefficients, and constants in \( 5n - 2n - 3 + n \). (Example 1)

2. Write \( 4p - 7 + 6p + 10 \) in simplest form. (Examples 2 and 3)

3. The cost of a game \( g \) with 7% sales tax can be represented by the expression \( g + 0.07g \). Simplify the expression. Then determine the total cost of the game after sales tax if the original price is $52. (Example 4)

4. You go to a basketball game and buy 3 waters that cost \( x \) dollars each. Your brother buys a bottle of water and a bag of peanuts that costs $4.50. Write an expression in simplest form that represents the total amount of money spent altogether. (Example 5)

5. Building on the Essential Question Explain why \( 2(x - 1) + 3(x - 1) = 5(x - 1) \) is a true statement.

Rate Yourself!

Are you ready to move on? Shade the section that applies.

YES ☑ NO

For more help, go online to access a Personal Tutor.
Identify the terms, like terms, coefficients, and constants in each expression. (Example 1)

1. \(2 + 3a + 9a\)
2. \(7 - 5x + 1\)
3. \(9 - z + 3 - 2z\)

Write each expression in simplest form. (Examples 2 and 3)

4. \(n + 5n = \)
5. \(12c - c = \)
6. \(-4j - 1 - 4j + 6 = \)

7. The cost of a ticket \(t\) to a concert with a 3% sales tax can be represented by the expression \(t + 0.03t\). Simplify the expression. Then determine the total cost after the sales tax if the original price is $72. (Example 4)

Write an expression in simplest form that represents the total amount in each situation. (Example 5)

8. You rent \(x\) pairs of shoes for $2 each. You buy the same number of drinks for $1.50 each. You also pay $9 for a bowling lane.

9. You watch \(x\) minutes of television on Monday, the same amount on Wednesday, and 30 minutes on Friday.

10. In a State Legislature, there were 119 more members in the House of Representatives than in the Senate. If there were \(m\) members in the Senate, write an expression to represent the total members in the State Legislature.

11. Elian and his friends paid a total of $7 for tickets to the school football game. While at the game, they bought 5 hot dogs at \(x\) dollars each, 4 boxes of popcorn at \(y\) dollars each, and 2 pretzels at \(z\) dollars each.

   a. Write an expression to show the total cost of admission and the snacks.

   b. Hot dogs cost $4, popcorn cost $3, and pretzels cost $2. What was the total cost for admission and snacks?
Reason Abstractly Write an expression in simplest form for the perimeter of each figure.

12. \[ \begin{array}{c}
4x \\
5x \\
2x \\
2.2y \\
\end{array} \quad 2.8y \]

13. \[ \begin{array}{c}
3a \\
5a \\
4 \\
3a \\
2b \\
6b \\
\end{array} \quad 2b \]

14. \[ \begin{array}{c}
4y \\
2h \\
\end{array} \]

H.O.T. Problems Higher Order Thinking

15. **Be Precise** Write an expression that has three terms and simplifies to \(4x - 7\). Identify the coefficient(s) and constant(s) in your expression.

16. **Which One Doesn’t Belong?** Identify the expression that is not equivalent to the other three. Explain your reasoning.

\[ \begin{array}{c}
x - 2 + 3x \\
4(x - 2) \\
-2 + 7x - 3x \\
4x - 2 \\
\end{array} \]

17. **Persevere with Problems** Simplify the expression \(8x - 2x + 12x - 3\). Show that your answer is true for \(x = 2\).

18. **Justify Conclusions** Determine whether the following statement is always, sometimes, or never true. Explain your reasoning.

*When using the Distributive Property, if the term outside the parentheses is negative, then the sign of each term inside the parentheses will change.*
Extra Practice

Identify the terms, like terms, coefficients, and constants in each expression.

19. $4 + 5y - 6y + y$
   terms: $4, 5y, -6y, y$
   like terms: $5y, -6y, y$
   coefficients: $5, -6, 1$
   constant: $4$

20. $n + 4n - 7n - 1$

21. $-3d + 8 - d - 2$

Write each expression in simplest form.

22. $5x + 4 + 9x$
   $= \underline{\hspace{2cm}}$

23. $2 + 3d + d'$
   $= \underline{\hspace{2cm}}$

24. $-3r + 7 - 3r - 12$
   $= \underline{\hspace{2cm}}$

Write an expression in simplest form that represents the total amount in each situation.

25. You subscribe to $m$ different magazines. Your friend subscribes to 2 fewer than you.

26. Today is your friend's birthday. She is $y$ years old. Her brother is 5 years younger.

27. You spent $m$ minutes studying on Monday. On Tuesday, you studied 15 more minutes than you did on Monday. Wednesday, you studied 30 minutes less than you did on Tuesday. You studied twice as long on Thursday as you did on Monday. On Friday, you studied 20 minutes less than you did on Thursday. Write an expression in simplest form to represent the number of minutes you studied in all.

28. **Reason Abstractly** Write a real-world situation for $7.50y + 9$.

Simplify each expression.

29. $3(4x - 5) + 4(2x + 6)$
   $= \underline{\hspace{2cm}}$

30. $-8(2a - 3b) - 5(6b - 4a)$
   $= \underline{\hspace{2cm}}$

31. $10(5g + 2h - 3) - 4(3g - 4h + 2)$
   $= \underline{\hspace{2cm}}$
32. Vince, Neal, and Patrick collect baseball cards. Neal has 3 fewer cards than twice the number of cards Vince has. Patrick has 5 more baseball cards than Vince. Let x represent the number of baseball cards that Vince has. Use the algebra tiles to represent the number of cards each person has.

<table>
<thead>
<tr>
<th>Model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Write an expression, in simplified form, for the number of baseball cards the three friends have altogether.

33. The table shows the number of tickets needed and the number of times Talia participated in different activities at a carnival. Write an expression, in simplified form, for the total number of tickets that Talia used.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Tickets</th>
<th>Times Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balloon Pop</td>
<td>3</td>
<td>a</td>
</tr>
<tr>
<td>Dunk Tank</td>
<td>4</td>
<td>b</td>
</tr>
<tr>
<td>Ring Toss</td>
<td>2</td>
<td>a</td>
</tr>
<tr>
<td>Trampoline</td>
<td>5</td>
<td>b</td>
</tr>
</tbody>
</table>

34. Mica spends $5 for her lunch and $2 for breakfast each day Monday through Friday. Use the Associative Property to find how much money she spends on lunch and breakfast for 4 weeks. 7.EE.1

Define a variable. Then write each phrase as an algebraic expression. 6.EE.2

35. Anna has volunteered 9 more hours than Tricia

36. the cost of a pair of jeans is 4 times the cost of a book

Evaluate each expression if x = 2, y = 10, and z = 4. 6.EE.2c

37. 5z - 10

38. y + 2 + x

39. x^3 + (y ÷ x)

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Real-World Link

Homework  Luke has 20 math problems and 11 science questions for homework. Cameron has 23 math problems and 10 science questions for homework.

1. The expression below represents the types of exercises that Luke has for homework.
   
   \[20 \text{ math problems} + 11 \text{ science questions}\]

2. Complete the expression that represents the types of exercises that Cameron has for homework.
   
   \[\underline{\text{math problems}} + \underline{\text{science questions}}\]

3. Suppose Luke has \(x\) math problems and 5 science questions for homework and Cameron has \(x\) math problems and 6 science questions. The algebra tiles below represent the total number of math problems and science questions for both boys. Write an expression in simplest form that represents the algebra tiles.

   \[
x \quad 1 1 1 1 1
   
   \quad 1 1 1
   
   \]

   Expression:

   \[x + 1 1 1 1 1 + 1 1 1\]

   Which \(\text{MP} \) Mathematical Practices did you use?

   Shade the circle(s) that applies.

   ① Persevere with Problems
   ② Reason Abstractly
   ③ Construct an Argument
   ④ Model with Mathematics
   ⑤ Use Math Tools
   ⑥ Attend to Precision
   ⑦ Make Use of Structure
   ⑧ Use Repeated Reasoning
Add Linear Expressions

A linear expression is an algebraic expression in which the variable is raised to the first power and variable are not multiplied or divided. The table below gives some examples of expressions that are linear and some examples of expressions that are not linear.

<table>
<thead>
<tr>
<th>Linear Expressions</th>
<th>Nonlinear Expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5x$</td>
<td>$5mn$</td>
</tr>
<tr>
<td>$3x + 2$</td>
<td>$3x^2 + 2$</td>
</tr>
<tr>
<td>$x - 7$</td>
<td>$x^4 - 7$</td>
</tr>
</tbody>
</table>

You can add linear expression with or without models. Sometimes you will need to use zero pairs.

**Examples**

**Add.**

1. $(2x + 3) + (x + 4)$

   Model each linear expression.

   Combine like tiles and write a linear expression for the combined tiles.

   So, $(2x + 3) + (x + 4) = 3x + 7.$

2. $(2x - 1) + (x - 5)$

   $(2x - 1) + (x - 5) = [2x + (-1)] + [x + (-5)]$  
   Definition of subtraction

   $2x + (-1)$

   $+ x + (-5)$  
   Arrange like terms in columns.

   $3x + (-6)$  
   Add.

   So, $(2x - 1) + (x - 5) = 3x + (-6)$ or $3x - 6.$

**Got It?** Do these problems to find out.

a. $(3x + 5) + (2x + 3)$  

b. $(2x - 4) + (3x - 7)$
Examples

3. Find \((2x - 3) + (-x + 4)\). Use models if needed.

\[
\begin{align*}
2x &+ (-3) \\
-x &+ 4
\end{align*}
\]

Model each linear expression.

Combine like tiles. Then remove all zero pairs and write a linear expression for the remaining tiles.

So, \((2x - 3) + (-x + 4) = x + 1\).

4. Find \(2(x + 3) + (3x + 1)\).

\[
\begin{align*}
2(x + 3) + (3x + 1) &= (2 \cdot x + 2 \cdot 3) + (3x + 1) \\
&= (2x + 6) + (3x + 1) \\
2x &+ 6 \\
+ 3x &+ 1 \\
5x &+ 7
\end{align*}
\]

Use the Distributive Property.
Simplify.

Arrange like terms in columns.
Add.

So, \(2(x + 3) + (3x + 1) = 5x + 7\).

5. Find \(5(x - 4) + (2x - 7)\).

\[
\begin{align*}
5(x - 4) + (2x - 7) &= (5 \cdot x - 5 \cdot 4) + (2x - 7) \\
&= (5x - 20) + (2x - 7) \\
5x &- 20 \\
+ 2x &- 7 \\
7x &- 27
\end{align*}
\]

Use the Distributive Property
Simplify.

Arrange like terms in columns.
Add.

So, \(5(x - 4) + (2x - 7) = 7x - 27\).

Got It? Do these problems to find out.

Add. Use models if needed.

\[
\begin{align*}
c. (x - 1) + (2x + 3) \\
d. (x - 4) + (-2x + 1) \\
e. 6(x + 7) + (x + 3) \\
f. (12x + 19) + 2(x - 10)
\end{align*}
\]
Example

6. Write a linear expression in simplest form to represent the perimeter of the triangle. Find the perimeter if the value of \( x \) is 5 centimeters.

Write a linear expression for the perimeter of the triangle.

\((3x - 3) + (2x + 9) + (5x)\)  
\((3x + 2x + 5x) + (-3 + 9)\)

\[10x + 6\]

Find the perimeter.

\[10x + 6 = 10(5) + 6\ or\ 56\]

So, the perimeter of the triangle is 56 centimeters.

Got It? Do this problem to find out.

g. A rectangle has side lengths \((x + 4)\) feet and \((2x - 2)\) feet. Write a linear expression in simplest form to represent the perimeter. Find the perimeter if the value of \( x \) is 7 feet.

Guided Practice

Add. Use models if needed. (Examples 1–5)

1. \((2x + 3) + (x + 1) = \)

2. \(10(x - 2) + (6x - 6) = \)

3. Write a linear expression in simplest form to represent the perimeter of the pentagon. Then find the perimeter if the value of \( x \) is 3 yards. (Example 6)

4. Building on the Essential Question Explain how adding linear expressions is similar to simplifying expressions.

Rate Yourself!

How confident are you about adding linear expressions? Check the box that applies.

For more help, go online to access a Personal Tutor.

Foldables Time to update your Foldable!
Add. Use models if needed. (Examples 1–5)

1. \((4x + 8) + (7x + 3) = \) 
2. \((-3x + 7) + (-6x + 9) = \) 
3. \((x - 10) + (3x - 6) = \) 
4. \((-3x - 7) + (4x + 7) = \)
5. \(2(x + 14) + (2x - 14) = \)
6. \((11x - 8) + 7(x - 1) = \)

7. Write a linear expression in simplest form to represent the perimeter of the triangle at the right. Then find the perimeter if the value of \(x\) is 10 millimeters. (Example 6)

\[
\text{Perimeter} = (7x + 8) + (6x + 6) + (9x - 4)
\]

8. A rectangle has side lengths \((2x - 5)\) meters and \((2x + 6)\) meters. Write a linear expression in simplest form to represent the perimeter. Find the perimeter if the value of \(x\) is 12 meters. (Example 5)

9. Find the sum of \((x + 5), (-4x - 2),\) and \((2x - 1)\).

Add.

10. \((-3.5x + 1.7) + (9.1x - 0.3) = \)
11. \((0.5x + 15) + (8.2x - 16.6) = \)
12. **Reason Abstractly**  The table shows the breakdown of the points scored in last week's basketball game.

<table>
<thead>
<tr>
<th></th>
<th>1st Quarter Field Goal Points</th>
<th>2nd Quarter Field Goal Points</th>
<th>3rd Quarter Field Goal Points</th>
<th>4th Quarter Field Goal Points</th>
<th>Total Free Throw Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panthers</td>
<td>$2x - 6$</td>
<td>$x + 2$</td>
<td>$2x$</td>
<td>$x - 6$</td>
<td>$9$</td>
</tr>
</tbody>
</table>

a. Write a linear expression in simplest form to represent the total field goal points scored in the first two quarters.

b. Write a linear expression in simplest form to represent the total points scored in the game.

**H.O.T. Problems**  Higher Order Thinking

13. **Reason Inductively**  Write two linear expressions with a sum of $-5x + 4$.

14. **Construct an Argument**  Will the sum of two linear expressions, each with an $x$-term, always, sometimes, or never have an $x$-term? Explain your reasoning.

15. **Persevere with Problems**  An integer can be represented by $x$. The next integer can then be represented as $(x + 1)$. Write a linear expression that represents the sum of any two consecutive integers. Show that the sum of any two consecutive integers is always odd.

16. **Reason Inductively**  Explain how algebra tiles represent like terms and zero pairs.
Add. Use models if needed.

17. \((-x + 10) + (-3x + 6) = \) \(_{-4x + 16}\)

18. \((-4x + 3) + (-2x + 8) = \) __________

19. \((-6x + 5) + (4x - 7) = \) __________

20. \((-4x + 5) + (15x - 3) = \) __________

21. \((-5x + 4) - (-1x - 1) = \) __________

22. \(17(2x - 5) + (-x + 4) = \) __________

23. Write a linear expression in simplest form to represent the perimeter of the trapezoid at the right. Then find the perimeter if the value of \(x\) is 7 yards.

24. **Reason Abstractly** The table shows the points earned by a contestant in four rounds on a game show.

<table>
<thead>
<tr>
<th>Round 1</th>
<th>Round 2</th>
<th>Round 3</th>
<th>Round 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(x + 40)</td>
<td>5(x + 12)</td>
<td>100</td>
<td>6(x - 10)</td>
</tr>
</tbody>
</table>

a. Write a linear expression in simplest form to represent the total points earned by the contestant in rounds 1 and 2.

b. Write a linear expression in simplest form to represent the total points earned in all four rounds.

c. If the value of \(x\) is 8, what is the total points earned in all four rounds?
25. Karina makes $x$ dollars per hour working at the grocery store. She makes $y$ dollars per hour working at the library. One week she worked 9 hours at the grocery store and 12 hours at the library. Determine if each statement is true or false.
   a. The expression $21x$ represents Karina's earnings from the library.  
      [True/False]
   b. The expression $9y$ represents Karina's earnings from the grocery store.  
      [True/False]
   c. The expression $9x + 12y$ represents Karina's total earnings for the week.  
      [True/False]

26. A triangle has the side lengths represented by the expressions shown in the figure. Select the appropriate numbers and expressions to complete the model representing the perimeter of the triangle.

   \[
   \begin{align*}
   x - 2 + 4x + 2 + 2x + 3 &= x - 1 + 2x + 1 + 5x + 3 + 7x + 7 - 2 \\
   \text{Perimeter} &= 16x - 2
   \end{align*}
   \]

---

**Common Core Spiral Review**

Use the Distributive Property to evaluate each expression. 6.EE.3

27. $7(9 - 4) =$  

28. $(9 + 2)6 =$  

29. $5(9 + 8) =$  

30. The number of students in each of the seventh grade homerooms that volunteer in the office are shown in the table. Use mental math to find the total number of students who volunteered. Explain. 6.EE.3

<table>
<thead>
<tr>
<th>Office Volunteers</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeroom</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>8</td>
</tr>
</tbody>
</table>
Dog Sledding  The Iditarod is a dog sledding race over 1,150 miles across Alaska. The table shows two winning times.

<table>
<thead>
<tr>
<th>Iditarod</th>
<th>Days</th>
<th>Hours</th>
<th>Minutes</th>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race 1</td>
<td>9</td>
<td>11</td>
<td>46</td>
<td>48</td>
</tr>
<tr>
<td>Race 2</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>41</td>
</tr>
</tbody>
</table>

1. What is the difference in hours, minutes, and seconds between the two races?

   h  min  s

2. Explain how you could find the difference in times between any two races, given the days, hours, minutes, and seconds.

3. Describe another situation in which finding the difference involves subtracting like units.

Which Mathematical Practices did you use?
Shade the circle(s) that applies.

① Persevere with Problems  ⑤ Use Math Tools
② Reason Abstractly  ⑥ Attend to Precision
③ Construct an Argument  ⑦ Make Use of Structure
④ Model with Mathematics  ⑧ Use Repeated Reasoning
Subtract Linear Expressions

When subtracting linear expressions, subtract like terms. Use zero pairs if needed.

**Examples**

**1.** $(6x + 3) - (2x + 2)$

```
   x  x  x  x  x  x  1  1
   +  3
```

Model the linear expression $6x + 3$.

```
   x  x  x  x  x  x  1  1
   -  2  x  -  2
```

To subtract $2x + 2$, remove two $x$-tiles and two 1-tiles. Then write the linear expression for the remaining tiles.

There are four $x$-tiles and one 1-tile remaining.
So, $(6x + 3) - (2x + 2) = 4x + 1$.

**2.** $(2x - 3) - (x - 2)$

```
   x  x  2  3
   +  (-3)
```

Model the linear expression $2x - 3$.

```
   x  x  2  3
   -  (-1  1)
```

To subtract $x - 2$, remove one $x$-tile and two $-1$-tiles. Then write the linear expression for the remaining tiles.

There is one $x$-tile and one $-1$-tile remaining.
So, $(2x - 3) - (x - 2) = x - 1$.

**Got It?** Do these problems to find out.

a. $(5x - 9) - (2x - 7)$

b. $(6x - 10) - (2x - 8)$
Example

3. Find \((-2x - 4) - (2x)\). Use models if needed.

Model the linear expression \(-2x - 4\).

Since there are no positive \(x\)-tiles to remove, add two zero pairs of \(x\)-tiles. Remove two positive \(x\)-tiles.

So, \((-2x - 4) - (2x) = -4x - 4\).

Got It? Do these problems to find out.

c. \((3x - 2) - (5x - 4)\)
d. \((4x - 4) - (-2x + 2)\)

Use the Additive Inverse to Subtract:

When subtracting integers, you add the opposite, or the additive inverse. The same process is used when subtracting linear expressions.

Examples

4. Find \((6x + 5) - (3x + 1)\).

\[
\begin{align*}
6x + 5 & \quad \text{Arrange like terms in columns.} \\
(+) -3x - 1 & \quad \text{The additive inverse of} \, 3x + 1 \, \text{is} \, (-3x - 1) \\
3x + 4 &
\end{align*}
\]

5. Find \((-4x - 7) - (-5x - 2)\).

\[
\begin{align*}
-4x - 7 & \quad \text{Arrange like terms in columns.} \\
(+) 5x + 2 & \quad \text{The additive inverse of} \, -5x - 2 \, \text{is} \, (5x + 2) \\
x - 5 &
\end{align*}
\]

Got It? Do these problems to find out.

e. \((4x - 3) - (2x + 7)\)
f. \((5x - 4) - (2x + 3)\)
Example

A hat store tracks the sale of college and professional team hats for \( m \) months. The number of college hats sold is represented by \((6m + 3)\). The number of professional hats sold is represented by \((5m - 2)\). Write an expression to show how many more college hats were sold than professional hats. Then evaluate the expression if \( m \) equals 10.

Find \((6m + 3) - (5m - 2)\).

\[
\begin{align*}
6m + 3 & \quad \text{Arrange like terms in columns.} \\
(+)-5m + 2 & \quad \text{The additive inverse of } 5m - 2 \text{ is } -(5m + 2). \\
\hline \\
m + 5 & \quad \text{Evaluate the expression if } m = 10. \\
\end{align*}
\]

\[
\begin{align*}
m + 5 & = 10 + 5 \\
& = 15 \\
\end{align*}
\]

So, 15 more college team hats were sold.

Guided Practice

Subtract. Use models if needed. (Examples 1–5)

1. \((2x + 4) - (-x + 5) = \)  
2. \((6x + 9) - (7x - 1) = \)

3. The number of runs scored by the home team at a baseball game is represented by \((x + 7)\). The number of runs scored by the visiting team is represented by \((3x - 7)\). Write an expression to find how many more runs the home team scored than the visiting team. Then evaluate the expression if the value of \( x \) is 6. (Example 6)

Rate Yourself!

How well do you understand subtracting linear expressions? Circle the image that applies.

- Clear
- Somewhat Clear
- Not So Clear

For more help, go online to access a Personal Tutor.

Building on the Essential Question  How can you use the additive inverse to help you subtract linear expressions?

406  Chapter 5  Expressions
Independent Practice

Subtract. Use models if needed. (Examples 1–5)

1. $(9x + 5) - (4x + 3) = \underline{\hspace{2cm}}$

2. $(-x + 3) - (x - 5) = \underline{\hspace{2cm}}$

3. $(3x + 4) - (x + 2) = \underline{\hspace{2cm}}$

4. $(7x + 5) - (3x + 2) = \underline{\hspace{2cm}}$

5. $(9x - 8) - (x + 4) = \underline{\hspace{2cm}}$

6. $(9x - 12) - (5x - 7) = \underline{\hspace{2cm}}$

7. **Reason Abstractly** The number of customers in a store on the first day is represented by $(6x - 3)$. The number of customers on the second day is represented by $(x - 1)$. Write an expression to find how many more customers visited the store on the first day. Then evaluate the expression if $x$ is equal to 50. (Example 6)

8. The perimeter of the garden shown is $(6x + 2)$ units. Find the length of the missing side.

9. The cost for shipping a package that weighs $x$ pounds from Boise to Los Angeles is shown at the right. How much more does Shipping Central charge than Globe Delivery?

<table>
<thead>
<tr>
<th>Company</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Central</td>
<td>$3x + 3.50$</td>
</tr>
<tr>
<td>Globe Delivery</td>
<td>$2x + 2.99$</td>
</tr>
</tbody>
</table>
10. Find the difference in the given lengths of the polygons.

(6x - 5) units  (7x + 2) units

**H.O.T. Problems** Higher Order Thinking

11. **Find the Error** Theresa is finding \((5x + 3) - (2x + 1)\). Find her mistake and correct it.

\[
(5x + 3) - (2x + 1)
= 5x + 3 - 2x + 1
= 5x - 2x + 3 + 1
= 3x + 4
\]

12. **Reason Inductively** Name two linear expressions whose difference is \(5x - 4\).

13. **Persevere with Problems** One linear expression is subtracted from a second linear expression and the difference is \(x - 5\). What is the difference when the second linear expression is subtracted from the first?

14. **Persevere with Problems** Suppose \(A\) and \(B\) represent linear expressions. If \(A + B = 2x - 2\) and \(A - B = 4x - 8\), find \(A\) and \(B\).

15. **Reason Inductively** Explain how you can apply the rule for subtracting integers to linear expressions.
Subtract. Use models if needed.

16. \((-3x - 2) - (7x + 9) = \) \(-10x - 11\)

\[
\begin{array}{c}
-3x - 2 \\
+ \quad -7x - 9 \\
\hline \\
-10x - 11
\end{array}
\]

17. \((-2x - 1) - (x - 7) = \)

18. \((9x + 5) - (6x - 8) = \)

19. \((-8x + 1) - (8x - 1) = \)

20. \((4x + 10) - (-3x + 5) = \)

21. \((-6x - 11) - (-2x - 4) = \)

22. **Reason Abstractly** The number of questions on a math test is represented \((3x + 1)\). The number of questions on a spelling test is represented by \((x + 12)\). Write an expression to find how many more questions were on the math test. Then evaluate the expression if the value of \(x\) is 8.

Subtract.

23. \((5.7x - 0.8) - (4.9x - 1.4) = \)

24. \((-\frac{5}{6}x + 5\frac{1}{2}) - (\frac{2}{3}x + 4) = \)

25. \(2(x + 1) - 3x = \)

26. \(5(x - 3) - x = \)
27. The costs for a large pizza and each topping for two pizzerias are shown in the table.

Select the appropriate values to complete the model to show how much more a pizza with \( t \) toppings costs at Pizza Palace than at Mario's Pizza.

\[
\begin{array}{cccc}
0.25 & 2.75 & 1.25 & 1.50 \\
2 & 10 & 12 & 22 \\
\end{array}
\]

\[
\text{____} + \text{____} t - (\text{____} + \text{____} t) = \text{____} + \text{____} t
\]

28. Mei wants to frame a picture. The picture is \((12x + 4)\) units long, and the frame is \((7x + 1)\) units long. Determine if each statement is true or false.

a. The picture is longer than the frame.          [□ True  □ False]
b. The frame is longer than the picture.          [□ True  □ False]
c. Mei will have to trim \((5x + 3)\) units from the picture to fit it in the frame. [□ True  □ False]

29. Camilla wants to attach a string of lights to the edges of her patio for a party. She does not want the string to go across the edge with the steps. Write a linear expression that represents the length of string in feet she will need. Then find the length if \( x = 3 \).

\[
4x - 2
\]

Evaluate each expression if \( x = \frac{1}{2} \) and \( y = \frac{3}{4} \).

30. \( xy \)    

31. \( x - y \)

32. \( x + y \)

33. \( x^3 \)

34. \( 3y + 2x \)

35. \( x ÷ y \)
Max has enough 1 inch square glass tiles to create a rectangular piece of mosaic art that has an area of 24 square inches. Some of the possible dimensions of the rectangle are listed in the table. Write the two missing possible dimensions.

Each of the dimensions listed are factors of 24. Sometimes, you know the product and are asked to find the factors. This process is called factoring.

### Hands-On Activity 1

Use algebra tiles to factor $2x + 6$.

**Step 1**  
Model the expression $2x + 6$.

**Step 2**  
Arrange the tiles into a rectangle with equal rows and columns. The total area of the tiles represents the product. Its length and width represent the factors.

The rectangle has a width of two 1-tiles and a length of one $x$-tile and three 1-tiles.

So, $2x + 6 = 2(x + \_\_\_\_\_\_\_\_\_)$. 

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**Hands-On Activity 2**

Use algebra tiles to factor \(2x - 8\).

**Step 1** Model the expression \(2x - 8\).

![Image of algebra tiles]

**Step 2** Arrange the tiles into a rectangle with equal rows and columns.

![Image of rectangle with tiles]

The rectangle has a width of two 1-tiles and a length of one \(x\)-tile and four \(-1\)-tiles.

So, \(2x - 8 = \) \_\_\_\_\_\_\_\_.

**Hands-On Activity 3**

Use algebra tiles to factor \(3x - 6\).

**Step 1** Draw the tiles that represent the expression \(3x - 6\).

![Image of blank area for tiles]

**Step 2** Redraw the tiles into a rectangle with equal rows and columns.

The rectangle has a width of \_\_\_\_\_\_\_\_\_ 1-tiles and a length of one \(x\)-tile and \_\_\_\_\_\_\_\_\_ \(-1\)-tiles.

So, \(3x - 6 = \) \_\_\_\_\_\_\_\_.

412 Chapter 5 Expressions
Work with a partner. Factor each expression by arranging the appropriate algebra tiles into equal rows and columns. Draw the finished product.

1. $4x + 6 = \underline{\hspace{3cm}}$

2. $5x + 10 = \underline{\hspace{3cm}}$

3. $3x + 12 = \underline{\hspace{3cm}}$

4. $4x - 10 = \underline{\hspace{3cm}}$

5. $3x - 9 = \underline{\hspace{3cm}}$

6. $2x - 4 = \underline{\hspace{3cm}}$

7. $4x + 2 = \underline{\hspace{3cm}}$

8. $5x - 5 = \underline{\hspace{3cm}}$
Work with a partner to complete the table. Use algebra tiles if needed.

<table>
<thead>
<tr>
<th>Original Expression</th>
<th>Factored Expression</th>
<th>Distributive Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2x + 8$</td>
<td>$2(x + 4)$</td>
<td>$2(x) + 2(4) = 2x + 8$</td>
</tr>
<tr>
<td>$4x - 8$</td>
<td>$4(x - \square)$</td>
<td>$4(x) - 4(2) = 4x - 8$</td>
</tr>
<tr>
<td>$6x + 2$</td>
<td>$2(x + 1)$</td>
<td>$2(3x) + 2(1) =$</td>
</tr>
<tr>
<td>$2x - 10$</td>
<td></td>
<td>$2(x) - 2(5) =$</td>
</tr>
<tr>
<td>$8x + 6$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. **Reason inductively** How is factoring related to using the Distributive Property?

14. **Construct an Argument** Is the expression $2x - 2$ equivalent to the expression $2(x - 2)$? Explain.

15. **Justify Conclusions** Explain how you could use algebra tiles to factor $5x + 15$.

16. **Inquiry** HOW do models help you factor linear expressions?
Real-World Link

Yard Sale: A rectangular yard is being separated into four equal-size sections for different items at a yard sale. The area of the yard is \((3x + 12)\) square meters.

1. How can you find the area of each section of the yard sale?

2. What is the area of each section? Explain your answer.

3. The algebra tiles represent the area of the entire yard sale. Fill in the length and width. Write an expression that represents the area in terms of the length and width of the model.

Which Mathematical Practices did you use? Shade the circle(s) that applies.

1. Persevere with Problems
2. Reason Abstractly
3. Construct an Argument
4. Model with Mathematics
5. Use Math Tools
6. Attend to Precision
7. Make Use of Structure
8. Use Repeated Reasoning

Essential Question
HOW can you use numbers and symbols to represent mathematical ideas?

Vocabulary
- monomial
- factor
- factored form

Common Core State Standards
Content Standards
7.EE.1, 7.EE.2
Mathematical Practices
1, 2, 3, 4

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Find the GCF of Monomials

A monomial is a number, a variable, or a product of a number and one or more variables.

<table>
<thead>
<tr>
<th>Monomials</th>
<th>Not Monomials</th>
</tr>
</thead>
<tbody>
<tr>
<td>25, x, 40x</td>
<td>x + 4, 40x + 120</td>
</tr>
</tbody>
</table>

To factor a number means to write it as a product of its factors. A monomial can be factored using the same method you would use to factor a number.

The greatest common factor (GCF) of two monomials is the greatest monomial that is a factor of both.

Examples

Find the GCF of each pair of monomials.

1. 4x, 12x

4x = 2 \cdot 2 \cdot x
12x = 2 \cdot 2 \cdot 3 \cdot x

Write the prime factorization of 4x and 12x.

circle the common factors.

The GCF of 4x and 12x is 2 \cdot 2 \cdot x or 4x.

2. 18a, 20ab

18a = 2 \cdot 3 \cdot 3 \cdot a
20ab = 2 \cdot 2 \cdot 5 \cdot a \cdot b

Write the prime factorization of 18a and 20ab.

circle the common factors.

The GCF of 18a and 20ab is 2 \cdot a or 2a.

3. 12cd, 36cd

12cd = 2 \cdot 2 \cdot 3 \cdot c \cdot d
36cd = 2 \cdot 2 \cdot 3 \cdot 3 \cdot c \cdot d

Write the prime factorization of 12cd and 36cd.

circle the common factors.

The GCF of 12cd and 36cd is 2 \cdot 2 \cdot 3 \cdot c \cdot d or 12cd.

Got It? Do these problems to find out.

Find the GCF of each pair of monomials.

a. 12, 28c
b. 25x, 15xy
c. 42mn, 14mn
Factor Linear Expressions

You can use the Distributive Property and the work backward strategy to express a linear expression as a product of its factors. A linear expression is in factored form when it is expressed as the product of its factors.

\[8x + 4y = 4(2x + y)\]
\[= 4(2x + y)\]

**The GCF of 8x and 4y is 4.**

**Distributive Property**

**Examples**

4. Factor 3x + 9.

**Method 1** Use a model.

<table>
<thead>
<tr>
<th>3</th>
<th>x + 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Arrange three x-tiles and nine 1-tiles into equal rows and columns. The rectangle has a width of three 1-tiles, or 3, and a length of one x-tile and three 1-tiles, or x + 3.

**Method 2** Use the GCF.

3x = 3 \cdot x
9 = 3 \cdot 3

Write the prime factorization of 3x and 9

Circle the common factors.

The GCF of 3x and 9 is 3. Write each term as a product of the GCF and its remaining factors.

\[3x + 9 = 3(x) + 3(3)\]
\[= 3(x + 3)\]

**Distributive Property**

So, 3x + 9 = 3(x + 3).

5. Factor 12x + 7y.

Find the GCF of 12x and 7y.

12x = 2 \cdot 2 \cdot 3 \cdot x
7y = 1 \cdot 7 \cdot y

There are no common factors, so 12x + 7y cannot be factored.

**Got It?** Do these problems to find out.

Factor each expression. If the expression cannot be factored, write cannot be factored. Use algebra tiles if needed.

\[d. \ 4x - 28\]
\[e. \ 3x + 33y\]
\[f. \ 4x + 35\]
Example

6. The drawing of a garden at the right has a total area of \((15x + 18)\) square feet. Find possible dimensions of the garden.

Factor \(15x + 18\).

\[
15x = 3 \cdot 5 \cdot x \\
18 = 2 \cdot 3 \cdot 3
\]

Write the prime factorization of \(15x\) and \(18\).

Circle the common factors.

The GCF of \(15x\) and \(18\) is \(3\). Write each term as a product of the GCF and its remaining factors.

\[
15x + 18 = 3(5x) + 3(6) \\
= 3(5x + 6)
\]

Distributive Property

So, the possible dimensions are \(3\) feet by \((5x + 6)\) feet.

Guided Practice

Find the GCF of each pair of monomials. ([Examples 1–3])

1. \(32x, 18\)  
2. \(27s, 54st\)  
3. \(18cd, 30cd\)

Factor each expression. If the expression cannot be factored, write cannot be factored. Use algebra tiles if needed. ([Examples 4 and 5])

4. \(36x + 24\)  
5. \(4x + 9\)  
6. \(14x – 16y\)

7. Mr. Phen's monthly income can be represented by the expression \(25x + 120\) where \(x\) is the number of hours worked. Factor the expression \(25x + 120\). ([Example 6])

8. **Building on the Essential Question** Explain how the GCF is used to factor an expression. Use the term Distributive Property in your response.
Find the GCF of each pair of monomials. (Examples 1-3)

1. 24, 48m
2. 32a, 48b
3. 36k, 144km

Factor each expression. If the expression cannot be factored, write cannot be factored. Use algebra tiles if needed. (Examples 4 and 5)

4. 3x + 6
5. 2x - 15
6. 12x + 30y

7. The area of a rectangular dance floor is (4x - 8) square units. Factor 4x - 8 to find possible dimensions of the dance floor. (Example 6)

8. The area of a rectangular porch is (9x + 18) square units. Factor 9x + 18 to find possible dimensions of the porch. (Example 6)

9. Six friends visited a museum to see the new holograms exhibit. The group paid for admission to the museum and $12 for parking. The total cost of the visit can be represented by the expression $6x + $12. What expression would represent the cost of the visit for one person?

10. The diagram represents a flower border that is 3 feet wide surrounding a rectangular sitting area. Write an expression in factored form that represents the area of the flower border.
MP Reason Abstractly Write an expression in factored form to represent the total area of each rectangle.

11.  
\[
\begin{array}{c}
5x \\
20 \\
\end{array}
\]

12.  
\[
\begin{array}{c}
7 \\
43x \\
\end{array}
\]

13.  
\[
\begin{array}{c}
36 \\
20x \\
40 \\
\end{array}
\]

14.  
\[
\begin{array}{c}
18 \\
6x \\
12 \\
\end{array}
\]

H.O.T. Problems Higher Order Thinking

15. MP Reason Inductively Write two monomials whose greatest common factor is 4m.

16. MP Find the Error Jamar is factoring 90x - 15. Find his mistake and correct it.

\[
90x - 15 = 15(6x) = 9
\]

17. MP Persevere with Problems The area of a rectangle is found using the formula \( A = \ell w \), where \( \ell \) is the length and \( w \) is the width of the rectangle. Write an expression in factored form that represents the area of the shaded region at the right.
Extra Practice

Find the GCF of each pair of monomials.

18. $63p, 84$  
   $63p = 3 \cdot 7 \cdot 3 \cdot p$  
   $84 = 2 \cdot 2 \cdot 3 \cdot 7$  
   The GCF of $63p$ and $84$ is $3 \cdot 7$ or $21$.

21. $40x, 60x$  
   $40x = 2 \cdot 2 \cdot 2 \cdot 5 \cdot x$  
   $60x = 2 \cdot 2 \cdot 3 \cdot 5 \cdot x$  
   The GCF of $40x$ and $60x$ is $2 \cdot 2 \cdot 5$ or $20x$.

22. $54gh, 72g$  
   $54gh = 2 \cdot 3 \cdot 3 \cdot 3 \cdot g \cdot h$  
   $72g = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot g$  
   The GCF of $54gh$ and $72g$ is $2 \cdot 3 \cdot 3 \cdot g$ or $18g$.

23. $100xy, 75xyz$  

Factor each expression. If the expression cannot be factored, write cannot be factored. Use algebra tiles if needed.

24. $5x + 5$  
25. $18x + 6$  
26. $4x - 7$

27. $10x - 35$  
28. $32x + 24y$  
29. $30x - 40$

30. James has $120 in his savings account and plans to save $x each month for 6 months. The expression $6x + 120$ represents the total amount in the account after 6 months. Factor the expression $6x + 120$.

31. A square scrapbooking page has a perimeter of $(8x + 20)$ inches. What is the length of one side of the scrapbooking page?

Copy and Solve Write an expression in factored form that is equivalent to the given expression. Show your work on a separate piece of paper.

32. $\frac{1}{2}x + 4$  
33. $\frac{2}{3}x + 6$  
34. $\frac{3}{4}x - 24$

35. $\frac{5}{6}x - 30$  
36. $\frac{2}{5}x + 16$  
37. $\frac{3}{8}x + 18$
38. Select the correct terms to fill in the Venn diagram to show the factors of 12 and 18x.

Factors of 12  Factors of 18x

What is the GCF of 12 and 18x? Explain how the Venn diagram helped you find the GCF.

39. Which pairs of monomials have a GCF of 4a? Select all that apply.
- 8a, 18a
- 16a, 8b
- 16ab, 12a
- 28a, 20a

Common Core Spiral Review

Use the Distributive Property to rewrite each expression. 6.EE.1

40. 4(x + 1) =  
41. 3(a + 10) =  
42. 7(2b + 5) =  

43. The letters P, E, M, D, A, and S form PEMDAS. This is a mnemonic device that can be used to help you remember the order of operations. Each letter stands for something. Complete the organizer. 6.EE.3

P  →  Parentheses
E  →  Multiplication
M  →  Division
D  →  Addition
A  →  Subtraction
S  →  Subtraction
Shark Scientist

Are you fascinated by sharks, especially those that are found around the coasts of the United States? If so, you should consider a career as a shark scientist. Shark scientists use satellite-tracking devices, called tags, to study and track the movements of sharks. By analyzing the data transmitted by the tags, scientists are able to learn more about the biology and ecology of sharks. Their research is helpful in protecting shark populations around the world.
Tag, You’re It!

The fork length of a shark is the length from the tip of the snout to the fork of the tail. Use the information on the note cards to solve each problem.

1. Write an expression to represent the total length of a hammerhead shark that has a fork length of \( f \) feet.

2. Use the expression from Exercise 1 to find the total length of a hammerhead shark that has a fork length of 11.6 feet.

3. Write an expression to represent the average fork length of a tiger shark, given the average fork length \( s \) of a sandbar shark.

4. Use the expression from Exercise 3 to find the average fork length of a tiger shark if the average fork length of a sandbar shark is 129 centimeters.

5. Write an expression to find the average fork length of a white shark with a total length of \( t \) centimeters.

6. The total length of a white shark is 204 centimeters. Use the expression in Exercise 5 to find the approximate fork length of the white shark.

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Career Project

It’s time to update your career portfolio! Describe the skills that would be necessary for a shark scientist to possess. Determine whether this type of career would be a good fit for you.

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List several challenges associated with this career.
In the puzzle below, write a vocabulary term for each clue.

Across
2. a type of expression that contains a variable or variables
3. an algebraic expression that has no like terms and no parentheses is in this form (two words)
7. an ordered list of numbers
11. an example showing a statement is not true
12. the numerical factor of a multiplication expression
13. what is done to a variable to represent an unknown quantity

Down
1. expressions like 4(3 + 2) and 4(3) + 4(2)
2. a sequence in which each term is found by adding the same number
4. terms that include the same variable
5. a letter or symbol
6. a statement that is true for any number or variable
8. a branch of mathematics that uses variables
9. a number in a sequence
10. a term that contains a number only
Got it?

Draw a line to match each expression with its equivalent expression.

1. $3 + 1$       a. $8 - 4x$
2. $4(2 - x)$    b. $5x + 5$
3. $3x - 2 - x + 6$ c. $3(x + 7)$
4. $2(x + 2) + (3x + 1)$ d. $1 + 3$
5. $3x + 21$     e. $2x + 4$
Movie Time
The Townsends, a family of five, are going to the local movie theater. The family consists of two adults and three children. Mr. Townsend wants to calculate the cost of the night out. He looks up the admission prices online.

<table>
<thead>
<tr>
<th>Admission:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults — $10.50</td>
</tr>
<tr>
<td>Children — $6.50</td>
</tr>
<tr>
<td>All shows before 6 p.m. 1/2 price</td>
</tr>
</tbody>
</table>

Before leaving, Mr. Townsend decides that he will get some items at the theater concession stand, a large drink for each person and a large tub of popcorn for everyone to share. He will not know the prices of the items at the concession stand until they arrive.

Write your answers on another piece of paper. Show all of your work to receive full credit.

Part A
Write an expression that represents the cost of the admission prices and the concession stand items based on the available information. Let d represent the cost for a large drink and let p represent the cost of the popcorn. The initial expression must include parentheses. Then simplify the expression by using the Distributive Property and combining like terms.

Part B
Two children from next door join the Townsends. The neighbor children have movie passes and have already eaten, so Mr. Townsend will only need to pay for two more large drinks. At the concession stand, one of the children gives Mr. Townsend a five dollar bill to help pay for the drinks. Write an expression that represents the cost of the drinks for the neighbor children and includes the money given to Mr. Townsend.

Part C
While at the concession stand, Mr. Townsend sees that the large tub of popcorn is $7.50, and large drinks are $6 each. Using your answers from Part A and Part B, write an expression that represents the total cost. Then substitute the values for the popcorn and drinks in your expression. What is the total cost for the evening?
Reflect

Answering the Essential Question

Use what you learned about algebraic expressions to complete the graphic organizer. Then answer the chapter's Essential Question below.

**Essential Question**

HOW can you use numbers and symbols to represent mathematical ideas?

**Answer the Essential Question**

HOW can you use numbers and symbols to represent mathematical ideas?