7.3 Writing Equivalent Expressions

Learning Target: Apply properties of operations to generate equivalent algebraic expressions.

Success Criteria:
- I can explain what it means for algebraic expressions to be equivalent.
- I can apply the Commutative and Associative Properties to simplify algebraic expressions.
- I can apply the Distributive Property to simplify algebraic expressions.
- I can use the Distributive Property to combine like terms.

Exploration 1 Identifying Equivalent Expressions

Work with a partner.

a. Choose four values for a variable x. Then evaluate each expression for each value of x. Are any of the expressions *equivalent*? Explain your reasoning.

x				
$4 + x + 4$				

x				
$4(x + 4)$				

x				
$4 \cdot (x \cdot 4)$				

x				
$x + 4 + 4$				

x				
$4x + 16$				

x				
$(4 \cdot x) \cdot 4$				

5 MTR RELATE CONCEPTS
What does it mean for two *numerical* expressions to be equivalent? Use your answer to explain what it means for two *algebraic* expressions to be equivalent.

b. You have used the following properties to evaluate numerical expressions. Give an example of each property. Are these properties true for algebraic expressions? Explain your reasoning.

Commutative Property of Addition

Commutative Property of Multiplication

Associative Property of Addition

Associative Property of Multiplication

Distributive Property

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Algebraic Reasoning
MA.6.AR.1.4 Apply the properties of operations to generate equivalent algebraic expressions with integer coefficients.

7.3 Lesson

Key Vocabulary
like terms, *p. 309*

Algebraic expressions that result in the same number for any value of each variable are equivalent. You can use properties to write equivalent expressions.

Commutative Properties	$a + b = b + a$	$a \cdot b = b \cdot a$
Associative Properties	$(a + b) + c = a + (b + c)$	$(a \cdot b) \cdot c = a \cdot (b \cdot c)$
Distributive Property	$a(b + c) = ab + ac$	$a(b - c) = ab - ac$

Example 1 Using Properties to Write Equivalent Expressions

Simplify each expression.

a. $(6 + x) + 8$

$(6 + x) + 8 = (x + 6) + 8$ Commutative Property of Addition

$= x + (6 + 8)$ Associative Property of Addition

$= x + 14$ Add 6 and 8.

One way to check whether expressions are equivalent is to evaluate each expression for any value of the variable. In Example 1(a), use $x = 2$.

$(6 + x) + 8 \stackrel{?}{=} x + 14$

$(6 + 2) + 8 \stackrel{?}{=} 2 + 14$

$16 = 16$ ✓

b. $5(11y)$

$5(11y) = (5 \cdot 11)y$ Associative Property of Multiplication

$= 55y$ Multiply 5 and 11.

c. $12(-2y - 3)$

$12(-2y - 3) = 12(-2y) - 12(3)$ Distributive Property

$= -24y - 36$ Multiply.

1 MTR STAY POSITIVE

Describe the similarities between algebraic expressions and numerical expressions. How does this increase your confidence when simplifying algebraic expressions?

d. $9(6 + x + 2)$

$9(6 + x + 2) = 9(6) + 9(x) + 9(2)$ Distributive Property

$= 54 + 9x + 18$ Multiply.

$= 9x + 54 + 18$ Commutative Property of Addition

$= 9x + (54 + 18)$ Associative Property of Addition

$= 9x + 72$ Add 54 and 18.

Try It **Simplify the expression. Explain each step.**

1. $(c + 11) + 2$ **2.** $10 + (a + 9)$ **3.** $-5(4n)$

4. $7(-a + 2)$ **5.** $12(a + 3b)$ **6.** $7(2 + 6 - 4d)$

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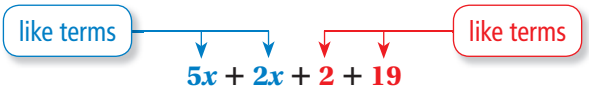
In an algebraic expression, **like terms** are terms that have the same variables raised to the same exponents. Constant terms are also like terms.



You can use the Distributive Property to *combine* like terms.

Example 2 Combining Like Terms

Simplify each expression.

a. $3x + 9 + 2x - 5$

$3x + 9 + 2x - 5 = 3x + 2x + 9 - 5$ Commutative Property of Addition

$= (3 + 2)x + 9 - 5$ Distributive Property

$= 5x + 4$ Simplify.

When you combine like terms, you are using the Distributive Property. You are applying the rules

$ab + ac = a(b + c)$ and $ab - ac = a(b - c)$.

b. $y + y + y$

$y + y + y = 1y + 1y + 1y$ Multiplicative Identity Property of One

$= (1 + 1 + 1)y$ Distributive Property

$= 3y$ Add coefficients.

c. $-7z + 2(z - 5y)$

$-7z + 2(z - 5y) = -7z + 2(z) - 2(5y)$ Distributive Property

$= -7z + 2z - 10y$ Multiply.

$= (-7 + 2)z - 10y$ Distributive Property

$= -5z - 10y$ Add coefficients.

Try It **Simplify the expression.**

7. $8 + 3z - z$

8. $3(b + 5) + b + 2$

In-Class Practice

1 I don't understand yet. 2 I can do it with help. 3 I can do it on my own. 4 I can teach someone else.

USING PROPERTIES **Simplify the expression. Explain each step.**

9. $(7 + c) + 4$

10. $-4(b \cdot 6)$

11. $15(4n - 2)$

12. $2w + 4 + 13w + 1$

13. WRITING Explain what it means for algebraic expressions to be equivalent. Then give an example of equivalent algebraic expressions.

14. OPEN-ENDED Write an algebraic expression that can be simplified using the Associative Property of Multiplication and the Commutative Property of Multiplication.

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Example 3 Modeling Real Life

Last year, a model airplane cost x dollars. This year, the price has increased $2. You decide to buy 3 model airplanes.

a. Write and simplify an expression that represents your total cost.

Use a table to organize the given information, and write an expression that represents each part of the question.

Description	Expression
Old unit price	x
New unit price	$x + 2$
Total cost	$3(x + 2)$

Simplify the expression that represents your total cost.

$3(x + 2) = 3(x) + 3(2)$ Distributive Property

$= 3x + 6$ Multiply.

▶ Your total cost in dollars is represented by $3x + 6$.

b. Last year, the model airplane cost $15. How much did you spend on the model airplanes?

Evaluate the expression $3x + 6$ when $x = 15$.

$3x + 6 = 3(15) + 6$ Substitute 15 for x.

$= 45 + 6$ Multiply 3 and 15.

$= 51$ Add 45 and 6.

▶ Your total cost this year is $51.

In-Class Practice

1 I don't understand yet. 2 I can do it with help. 3 I can do it on my own. 4 I can teach someone else.

15. You purchase a remote-controlled drone for d dollars. Your friend purchases a drone that costs $35 more than your drone. Your brother purchases a drone that costs three times as much as your friend's drone. Write and simplify an expression that represents the cost (in dollars) of your brother's drone.

16. You have $50 and a $15 gift card to spend online. You purchase a pair of headphones for $34.99 and 8 songs for x dollars each. Use an algebraic expression to find the amount you have left when each song costs $1.10.

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7.3 Practice WITH CalcChat® AND CalcView®

Review & Refresh

Write the phrase as an expression.

1. -10 added to a number p

2. the product of 6 and a number m

3. the quotient of a number b and -15

4. 7 fewer than a number s

You are given the difference of the numbers of boys and girls in a class and the ratio of boys to girls. How many boys and how many girls are in the class?

5. 3 more boys; 5 for every 4

6. 8 more girls; 3 for every 5

7. 4 more girls; 9 for every 13

8. 6 more boys; 7 for every 4

Evaluate the expression.

9. $8.092 + 3.5$

10. $16.78 - 12.237$

Concepts, Skills, & Problem Solving

MATCHING **Match the expression with an equivalent expression.** (See Exploration 1.)

11. $3 + 3 + y$

12. $(y \cdot y) \cdot 3$

13. $3(1 + y)$

14. $(3 + 0) + (y + y)$

A. $3 + 3y$

B. $y + 3 + 3$

C. $y(3 \cdot y)$

D. $(3 + y) + y$

SIMPLIFYING EXPRESSIONS **Simplify the expression.** (See Example 1.)

15. $-6 + (5 + x)$

16. $(14 + y) + 3$

17. $6(2b)$

18. $7(-9w)$

19. $3(x + 4)$

20. $9 \cdot c \cdot (-4)$

21. $(0 + a) + 8$

22. $10(b - 6)$

23. $(3s) \cdot 8$

24. $-9(2n + 1)$

25. $z \cdot 0 \cdot 12$

26. $18(5 - 3w)$

27. $-9(3 + c + 4)$

28. $8(5g + 5 - 2)$

29. $6(10 + z + 3)$

30. $-7(p + q + 9)$

4 MTR

31. **YOU BE THE TEACHER** Your friend names the property that the statement illustrates. Is your friend correct? Explain your reasoning.

$(7 + x) + 3 = (x + 7) + 3$

Associative Property of Addition

COMBINING LIKE TERMS **Simplify the expression.** (See Example 2.)

32. $6(x + 4) + 1$

33. $5 - 8(3 + x)$

34. $x + 3 + 5x$

35. $7y + 6 - 1 + 12y$

36. $4d + 9 - d - 8$

37. $-n + 3(n - 1)$

38. $2v + 8v - v$

39. $-5(z + 4) + 5(2 - z)$

40. $4x + 9y + 3(x + y)$

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41. **YOU BE THE TEACHER** Your friend simplifies the expression. Is your friend correct? Explain your reasoning.

$$8x - 2x + 5x = 8x - 7x$$
$$= (8 - 7)x$$
$$= x$$

42. **MODELING REAL LIFE** A cheetah can run 103 feet per second. A zebra can run x feet per second. Write and simplify an expression that represents how many feet farther the cheetah can run in 10 seconds. (See Example 3.)

43. **PROBLEM SOLVING** An art club sells 42 large candles and 56 small candles.

a. Write and simplify an expression that represents the profit.

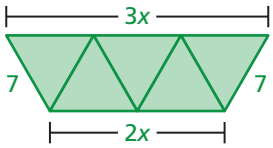
b. A large candle costs \$5, and a small candle costs \$3. What is the club's profit?

Profit = Price − Cost

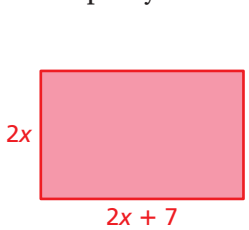
44. **GEOMETRY** Five identical triangles form the trapezoid shown.

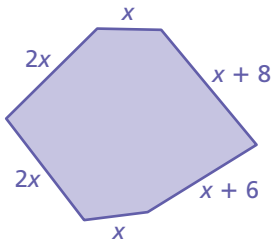
a. What is the perimeter of the trapezoid?

b. How can you use some or all of the triangles to form a new trapezoid with a perimeter of $3x + 14$? Explain your reasoning.



45. **REASONING** Find the difference between the perimeters of the rectangle and the hexagon. Interpret your answer.





46. **Dig Deeper** You and a friend sell hats at a fair booth. You sell 16 hats on the first shift and 21 hats on the third shift. Your friend sells x hats on the second shift.

a. The expression $37(14) + 10x$ represents the amount (in dollars) that you both earn. How can you tell that your friend is selling the hats for a lower price?

b. You earn more money than your friend. What can you say about the value of x?

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