Write and Evaluate Expressions with Variables

Study the example showing how to write and evaluate expressions with variables. Then solve problems 1–7.

Example

The number of runners on a marathon team this year is 6 more than 4 times the number of runners on last year’s team. Half of the runners this year are female and half are male. What expression represents the number of female runners on the team this year?

You can draw a model to represent the situation.

The model shows that the number of female runners can be represented by the expression $\frac{1}{2}(4r + 6)$.

1. What does $4r + 6$ represent in the expression?

2. Does the expression $\frac{(4r + 6)}{2}$ also represent the number of females on the team this year? Explain.

3. If there were only 9 runners on the team last year, how many female runners are on the team this year? Explain how you found the answer.

Vocabulary

**evaluate** to find the value of an algebraic expression.
Solve.

Use the situation below to solve problems 4–6.

The temperature increased 12°F between 9 AM and noon. It decreased 9°F between noon and 6 PM.

4 Write an expression with three terms to show the change in temperature. Let the first term represent the temperature at 9 AM.

5 If the temperature was 45°F at 9 AM, what was the temperature at 6 PM?

6 Suppose the temperature at 6 PM was 30°F. What would the temperature have been at 9 AM? Explain how you can use the expression you wrote in problem 4 to find the answer.

7 Jill makes purses and backpacks. To make each purse, she uses 1 foot less than \( \frac{1}{2} \) the amount of fabric she uses to make a backpack. Write an expression for the amount of fabric that Jill needs to make a purse. If she uses 6 feet of fabric to make a backpack, how many feet of fabric will she use to make a purse?

Show your work.

Solution: 

\[
\frac{1}{2} - 1 = \frac{1}{2}
\]
Properties of Operations

Study the example showing how to use properties of operations to write equivalent expressions with variables. Then solve problems 1–9.

Example

Sam bought 2 granola bars and Hayley bought 5 granola bars. Each granola bar was the same price.

Write an expression for the total price of the granola bars. Then simplify the expression to create an equivalent expression. Use the model to help you.

\[ 2b + 5b = b(2 + 5) = 7b \]

1. What does \( b \) represent in the expressions?

2. What does \( 2b + 5b \) represent?

3. Does the expression \( 2b + 5b \) have like terms? Explain.

4. What is the common factor of each term in the expression \( 2b + 5b \)?

5. Explain how to use the distributive property to create an expression that is equivalent to \( 2b + 5b \).
Solve.

Use the situation below to solve problems 6–7.

Larry bought 12 containers of pasta salad for a school picnic. Each container held the same number of ounces of salad. Students finished the pasta salad in 8 of the containers.

6 Let $p$ equal the number of ounces of pasta salad in one container. Write an expression with two terms to represent how many ounces of pasta salad are left.

7 Simplify the expression you wrote in problem 6 to create an equivalent expression. Use the distributive property.

8 A soccer coach bought 16 medium T-shirts and 9 large T-shirts. Each T-shirt was the same price. Onaje and Paula tried to write equivalent expressions to represent the total price of the T-shirts. The expressions they wrote are shown below.

Onaje: $16t + 9t = t(16 + 9) = 25t$
Paula: $16t + 9t = 16 + 9 + 2t = 25 + 2t$

Whose expression is correct? Why is the other expression incorrect?

9 Adem writes $18y$ to simplify an expression with three like terms.
   a. What could the expression be?

   b. Simplify the expression you wrote for part (a) to check your answer.
Properties and Equivalent Expressions

Study the example showing how to use properties of operations to write equivalent expressions with variables. Then solve problems 1–9.

Example

Four students are buying tickets to a play. The tickets cost $5 each plus a service fee. The expression 4(5 + x) represents the total cost. Write an expression that is equivalent to 4(5 + x).

You can use math tiles to model 4(5 + x).

From the math tiles, you can see that the expression 4(5 + x) = (5 + 5 + 5 + 5) + (x + x + x + x).

1. Explain how the model shows 4(5 + x).

2. Simplify the expression in the example.

3. What are the factors in the expression 4(5 + x)?

4. Show how to use the distributive property to simplify 4(5 + x).

5. Are the expressions (5 + 5 + 5 + 5) + (x + x + x + x) and 4(5 + x) equivalent? If so, write another expression that is equivalent to both of them. If not, explain why not.
Solve.

6. Use the distributive property to find two expressions that are equivalent to $7(3x - 4)$.

7. A rectangular play area is 8 yards long. The expression $56 + 8x$ represents the area of the play area in square yards. What expression represents the width of the play area in yards? Draw a picture to model the problem.

   *Show your work.*

Solution: _____________________________________________

8. Use the distributive property to write two expressions that are equivalent to $12 + 30x$. Describe the steps you follow to find the expressions.

   _____________________________________________

   _____________________________________________

   _____________________________________________

9. Are $9(4 - x)$ and $36 - 9x$ equivalent expressions? Explain how you know.

   _____________________________________________
Determine Whether Expressions Are Equivalent

Study the example problem showing how to determine whether expressions are equivalent. Then solve problems 1–7.

**Example**

Is $2s + 3s^2$ equivalent to $5s$?

Use math tiles to model $2s + 3s^2$ and $5s$.

The expression $2s + 3s^2$ is not equivalent to $5s$.

1. Are the terms $2s$ and $3s^2$ like terms? Explain.

2. Explain how the tiles show that $2s + 3s^2$ is not equivalent to $5s$.

3. Use substitution to prove that $2s + 3s^2$ is not equivalent to $5s$.

4. Use the distributive property to write an expression that is equivalent to $2s + 3s^2$.  

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Solve.

5 Look at the expressions $s^2 + 2s^2$ and $3s^2$.

a. Draw math tiles to model $s^2 + 2s^2$ and $3s^2$. Does your model show that they are equivalent expressions? Explain.

b. Use substitution to check your answer in part (a).

6 Use the terms 4, $12a$, 6, $2a$, and 24 to make equivalent expressions. Use each term only once. Use substitution to prove that the expressions are equivalent.

Show your work.

Solution: ________________________________

7 Bethany says that $3x + 6 + x$ and $3(x + 2)$ are equivalent expressions. She used substitution to support her answer. Explain what Bethany did wrong.

Let $x = 2$.

$3x + 6 + x = 3(2) + 6 + 2 = 6 + 6 = 12$

$3(x + 2) = 3(2 + 2) = 3(4) = 12$

$12 = 12$
Equivalent Expressions

Solve the problems.

1. Are $5n + 9 + n$ and $3(2n + 9)$ equivalent expressions? Use substitution to check your answer.

   Show your work.

   Solution: ____________________________

2. The picture shows the dimensions of a vegetable garden and a flower garden.

   How do you find the area of a rectangle?

   Which expression represents the combined area of the gardens in square feet? Select all that apply.

   A. $42 + 6x$
   B. $(6 \cdot 7) + (6 \cdot x)$
   C. $13 + 6 + x$
   D. $6(7 + x)$

   William chose C as a correct answer. How did he get that answer?

   ______________________________________
   ______________________________________
3. Look at the expression $\frac{1}{2}(c + 8)$. Tell whether each statement about the expression is True or False.

a. $\frac{1}{2}(c + 8)$ and $\frac{c + 8}{2}$ are equivalent expressions. □ True □ False

b. $\frac{1}{2}(c + 8)$ and $\frac{1}{2}c + 4$ are equivalent expressions. □ True □ False

c. The only terms in $\frac{1}{2}(c + 8)$ are $c$ and 8. □ True □ False

d. You can multiply $c$ and 8 by $\frac{1}{2}$ in $\frac{1}{2}(c + 8)$ to find an equivalent expression. □ True □ False

4. The expressions $a(8x + 7)$ and $4x + 3.5$ are equivalent. What is the value of $a$?

Show your work.

Solution: ________________________________

5. Which expression is equivalent to $6 + 7n + 4 + 8n$?
Select all that apply.

A. $13n + 12n$
B. $5(3n + 2)$
C. $5(3n + 10)$
D. $15n + 10$