

Solve & Discuss It!

How many toothpicks make a triangle? Two triangles? Write an expression that represents the number of toothpicks needed to make x triangles that appear side-by-side in a single row, as shown. Explain your reasoning.

Look for Relationships What do you notice about the number of toothpicks needed for more than 1 triangle?

Lesson 4-8

Analyze Equivalent Expressions

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I can...
use an equivalent expression to find new information.

Focus on math practices

Reasoning Can there be more than one expression that represents the total number of toothpicks needed to make x triangles in the arrangement shown? Explain.

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Essential Question How can writing equivalent expressions show how quantities are related?

EXAMPLE 1 Write Equivalent Expressions

A new box of pasta claims that it contains 25% more than the usual box. What expression shows the amount of pasta, p , in the new box?

Use Structure What expressions can you write to represent a percent greater than the original amount?

Draw a bar diagram to represent the problem situation. Then write an expression to represent the amount of pasta in the new box.

$p + 0.25p$

Combine like terms to write an equivalent expression.

The coefficient of p is 1.

$(1)p + 0.25p$
 $= 1.25p$
25% more than 100% is the same as 125%.

Try It!

Joe is buying gift cards that are on sale for 15% off. He uses $c - 0.15c$ to determine the sale price of gift cards. What is an equivalent expression that Joe could also use to determine the sale price of a gift card?

$c - 0.15c$ or
 c

Convince Me! How do you know if an expression is describing a percent increase or a percent decrease?

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EXAMPLE 2 Analyze Equivalent Expressions

Some middle school students will use 1-foot tiles to create a frame around a large square mural painting with side lengths s feet. Three students each wrote an expression to determine the number of tiles needed. Are these expressions equivalent? Explain.

$4(s+1)$

Each section requires $s+1$ tiles and there are 4 sections.

$s+s+s+s+4$

Each side requires s tiles and there are 4 sides, so $s+s+s+s$, plus 4 corner tiles.

$2s+2(s+2)$

The top and bottom of the frame require $s+2$ tiles and the two sides require s tiles.

Look for Relationships
What does each expression tell you about the relationship among quantities and variables?

The three expressions are equivalent because they each represent the number of tiles needed for the frame around the painting.

EXAMPLE 3 Interpret Equivalent Expressions

A table with a rectangular top has been extended with a table leaf as shown.

Multiply $3.5(6.5 + x)$ to write an equivalent expression for the total area of the extended table. What does each term of the equivalent expression tell you about the table?

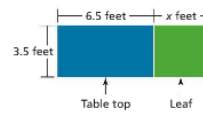
$$3.5(6.5 + x)$$

$$= (3.5 \cdot 6.5) + (3.5 \cdot x)$$

$$= 22.75 + 3.5x$$

Area, in ft^2 , of original table

Area, in ft^2 , of table leaf



Try It!

The total area, in square feet, of a rectangular stage that has been widened by x feet is represented by $1,900 + 76x$. Use the Distributive Property to factor the expression. What does each factor in the equivalent expression tell you about the stage?



KEY CONCEPT

Rewriting expressions can clarify relationships among quantities or variables.

When you *rewrite* an expression, you are writing an *equivalent* expression.

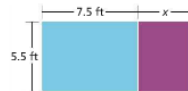
$4x + 12$ is equivalent to $4(x + 3)$ is equivalent to $x + x + x + x + 3 + 3 + 3$

$(3x+2)(3x+2)(3x+2)(3x+2)$

Do You Understand?

1. **Essential Question** How can writing equivalent expressions show how quantities are related?

2. **Use Structure** The total area, in square feet, of a rectangular mural that has been extended by x feet is represented by $5.5(7.5 + x)$. Expand the expression using the Distributive Property. What do each of the terms in the equivalent expression tell you about the mural?



3. The expression $(2x + 6) + x$ represents the perimeter of an isosceles triangle. If x represents the length of one side of the triangle, explain how you can use the Distributive Property to find the length of each of the two equivalent sides?

Do You Know How?

4. Rewrite the expression $12x + 8$ to find an equivalent expression. Show three possible expressions. What do the rewritten expressions tell you about the relationships among the quantities?

$4(3x+2)$

5. A rope is used to make a fence in the shape of an equilateral triangle around a newly planted tree. The length of the rope is represented with the expression $9x + 15$.

a. Rewrite the expression to represent the three side lengths of the rope fence.

$3(3x+5)$
Each side is $(3x+5)$ units.

b. What is the length of one side?
6. The expression $(x - 0.35x)$ represents 35% off the cost of an item x . How is this equivalent to multiplying x by 0.65?

Handwritten notes and diagrams:

- Diagram of a triangle with side length $3x+2$ and perimeter $3(3x+2)$.
- Diagram of a tree with a triangle around it, labeled "all sides equal".
- Handwritten algebra: $4 \overline{) 12x + 8}$ resulting in $3x + 2$ and $4(3x + 2)$.
- Handwritten algebra: $3 \overline{) 9x + 15}$ resulting in $3x + 5$ and $3(3x + 5)$.

Name: _____

Practice & Problem Solving

7. Reasoning Eric is planning an event at a hotel. Let g stand for the number of Eric's guests. The two expressions represent the difference between the cost of the rooms. Expression 1: $(326 + 37g) - (287 + 23g)$. Expression 2: $39 + 14g$. What can you tell about Expression 2 and Expression 1?

$$\begin{aligned}
 & 326 + 37g + (-287 + -23g) \\
 & (326 + -287) + (37g + -23g) \\
 & 14g + 39
 \end{aligned}$$

Hotel Function Rooms	
Ocean	
Booking Fee	\$326
Price per Guest	\$37
Harbor	
Booking Fee	\$287
Price per Guest	\$23

$$\begin{array}{r}
 326 \\
 + 37g \\
 \hline
 287 \\
 + 23g \\
 \hline
 39
 \end{array}$$

8. A student received a coupon for 17% off the total purchase price at a clothing store. Let b be the original price of the purchase. Use the expression $b - 0.17b$ for the new price of the purchase. Write an equivalent expression by combining like terms.

9. Kirana buys boxes of crackers that each have the same cost, c . She represents the cost of 3 boxes of cheese crackers, 2 boxes of poppy seed crackers, and 2 boxes of plain crackers using the expression $3c + 2c + 2c$. What equivalent expression can represent the cost?

$$\begin{aligned}
 & 3c + 2c + 2c \\
 & 7c
 \end{aligned}$$

10. A student received a coupon for 14% off the total purchase price at a clothing store. Let c be the original price of the purchase. The expression $c - 0.14c$ represents the new price of the purchase. Write an equivalent expression to show another way to represent the new price.

11. A farmer recently sold a large plot of land. The sale decreased his total acreage by 8%. Let v be the original acreage.

- Find two equivalent expressions that will give the new acreage.
- Use the expressions to describe two ways to find the new acreage.

12. An art teacher enlarged the area of a copy of a painting by 49%. Let d represent the area of the original painting. The expression $d + 0.49d$ is one way to represent the area of the new painting. Write two additional expressions that will give the area of the new painting.

13. Use Structure The area of a rectangular playground has been extended on one side. The total area of the playground, in square meters, can be written as $352 + 22x$.

Rewrite the expression to give a possible set of dimensions for the playground.

14. The manager of a store increases the price of a popular product by 7%. Let t be the original price of the product. The new price is $t + 0.07t$.

- Find an expression equivalent to $t + 0.07t$.
- If the original price was \$19.99, estimate the new price by first rounding the original price to the nearest dollar.

15. Higher Order Thinking A customer at a clothing store is buying a pair of pants and a shirt. The customer can choose between a sale that offers a discount on pants, or a coupon for a discount on the entire purchase. Let n represent the original price of the pants and s represent the price of the shirt.

- Write two expressions that represent the "15% off sale on all pants" option.
- Write two expressions that represent the "10% off her entire purchase" option.
- If the original cost of the pants is \$25 and the shirt is \$10, which option should the customer choose? Explain.



Assessment Practice

16. At a college, the cost of tuition increased by 10%. Let b represent the former cost of tuition. Use the expression $b + 0.10b$ for the new cost of tuition.

PART A
Write an equivalent expression for the new cost of tuition.

PART B
What does your equivalent expression tell you about how to find the new cost of tuition?

