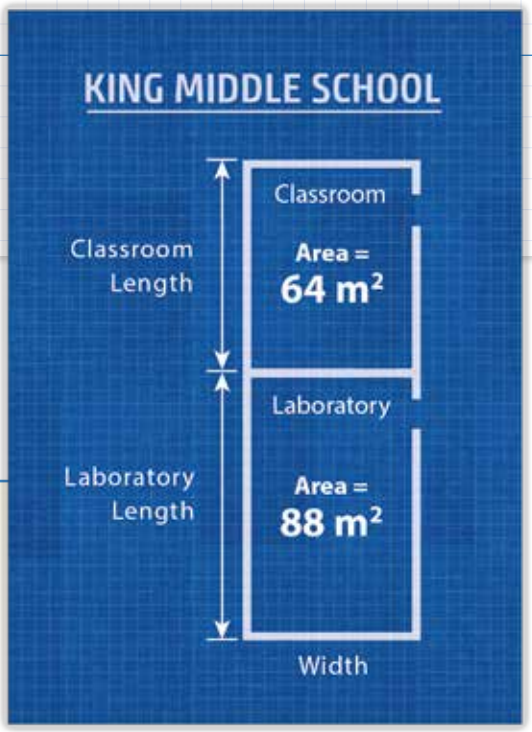
Explore Equivalent Expressions



Previously, you learned how to write and evaluate expressions. In this lesson, you will learn about equivalent expressions.

➤ **Use what you know to try to solve the problem below.**

In the design for a new school, a classroom needs to have the same width as a laboratory. The architect wants the width to be as great as possible. The length and width of each room should be a whole number of meters. What length and width should the architect use for each room?

TRY IT

Math Toolkit grid paper, sticky notes, unit tiles

DISCUSS IT

Ask: How did you determine the greatest possible width of the rooms?

Share: I started by . . . Then I . . .

Learning Targets SMP 1, SMP 2, SMP 3, SMP 4, SMP 5, SMP 6

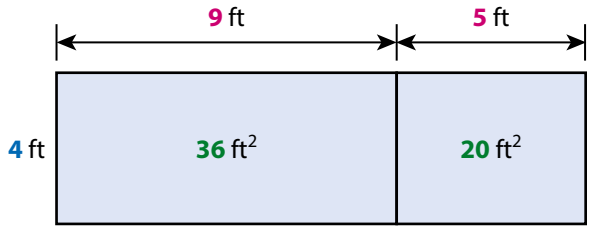
- Apply the properties of operations to generate equivalent expressions.
- Identify when two expressions are equivalent.
- Use the distributive property to express a sum of two whole numbers 1–100 with a common factor as a multiple of a sum of two whole numbers with no common factor.

CONNECT IT

1 Look Back What length and width should the architect use for the classroom and the laboratory? Explain how you know.

2 Look Ahead When two rectangles share a common side, the areas of the rectangles have a common factor.

a. The expressions 36 + 20 and 4(9 + 5) both represent the area, in square feet, of the outer rectangle. They are **equivalent expressions** because they name the same value. Show that these expressions are equivalent by finding the value of each expression.



36 + 20 = _____ 4(9 + 5) = 4 × _____

= _____

b. You can also use the distributive property to show that the sum 36 + 20 is equivalent to the product 4(9 + 5). To rewrite 36 + 20 as a product, you can use the greatest common factor (GCF) of 36 and 20 as one of the factors.

The GCF of 36 and 20 is _____. 36 + 20

Rewrite each term using the GCF as a factor. _____ × 9 + _____ × 5

Use the distributive property. _____ × (_____ + _____)

c. Rewrite the sum 42 + 35 as a product. Use the GCF of 42 and 35 as one of the factors. Use a sum as the other factor.

3 Reflect How can you use the distributive property to rewrite a sum of two terms as a product of two factors?

 Name:

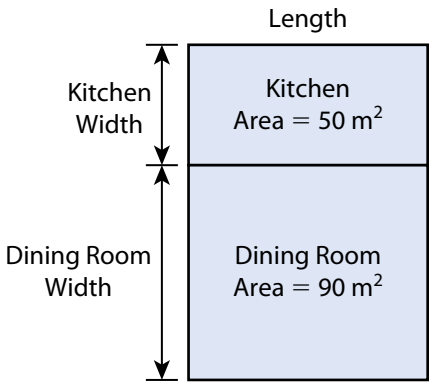
Prepare for Writing and Identifying Equivalent Expressions

1 Think about what you know about expressions. Fill in each box. Use words, numbers, and pictures. Show as many ideas as you can.

Word	In My Own Words	Examples
expression		
term		
coefficient		
distributive property		

2 What is the coefficient of n in the expression $n + 15$? Explain how you know.

3 An architect is designing a sandwich shop, as shown in the diagram. The kitchen and dining room will be the same length. The length needs to be as great as possible. The length and width of each room should be a whole number of meters.



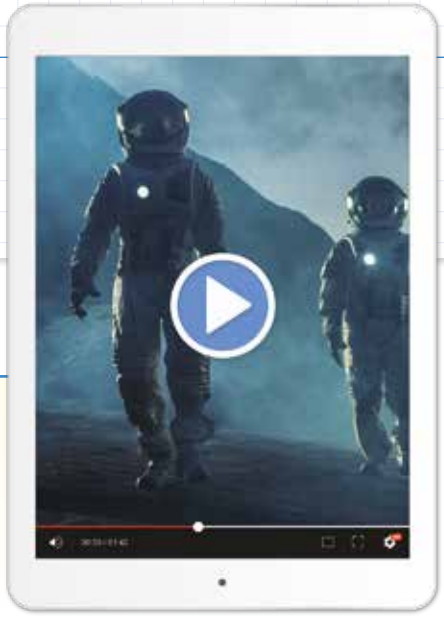
a. What length and width should the architect use for the kitchen and for the dining room? Show your work.

SOLUTION _____

_____

b. Check your answer to problem 3a. Show your work.

Develop Using the Distributive Property to Write Equivalent Expressions



➤ **Read and try to solve the problem below.**

The Romano family pays for a streaming movie service that costs $8 per month. They want to add a second movie service for d dollars per month. Write two expressions for the total cost of both services for 3 months. One expression should be a sum of two terms, and one should be a product of two factors.

TRY IT

Math Toolkit algebra tiles, grid paper

DISCUSS IT

Ask: What does each part of your two expressions represent?

Share: In my first expression, . . . In my second expression, . . .

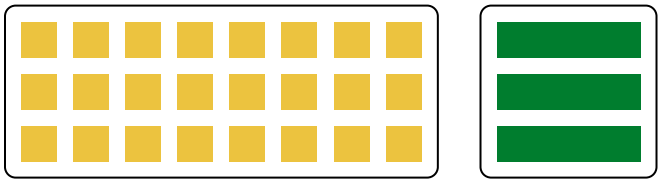
➤ **Explore different ways to understand using the distributive property to write equivalent expressions.**

The Romano family pays for a streaming movie service that costs $8 per month. They want to add a second movie service for d dollars per month. Write two expressions for the total cost of both services for 3 months. One expression should be a sum of two terms, and one should be a product of two factors.

Model It

You can use algebra tiles to help you write an algebraic expression.

Each square tile represents $1. Each rectangular tile represents d dollars.



The tiles show that the expression $24 + 3d$ represents the total cost of both services for 3 months.

Analyze It

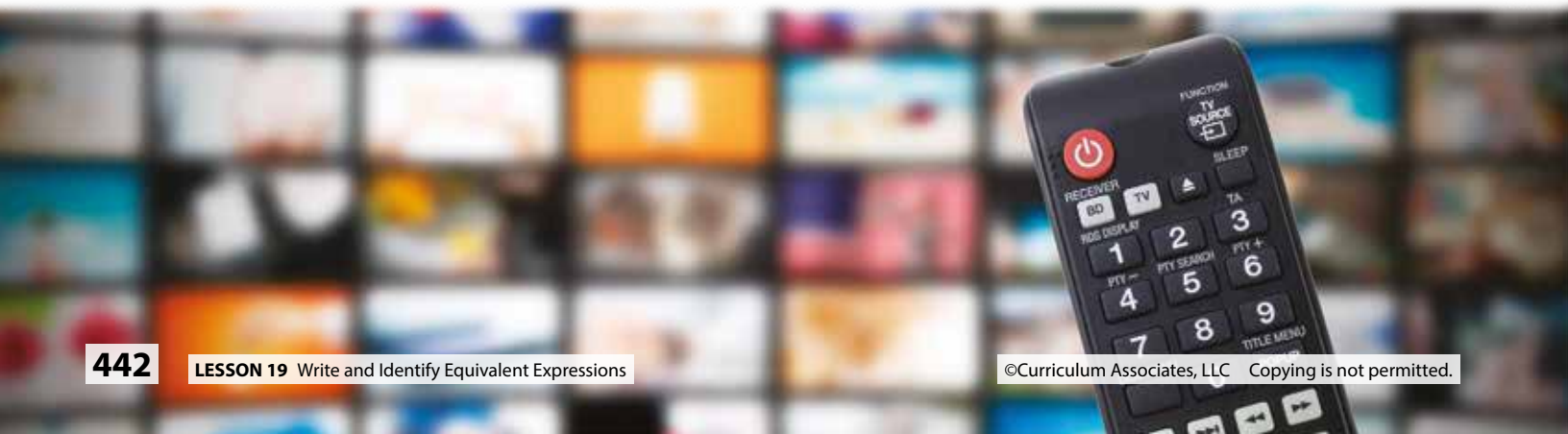
You can use the distributive property to find an equivalent expression.

Rewrite the expression $24 + 3d$ as a product of two factors. One factor is a common factor of the two terms.

$24 + 3d$

$\mathbf{3}(8) + \mathbf{3}(d)$ ← The GCF of 24 and $3d$ is **3**.

$\mathbf{3}(8 + d)$

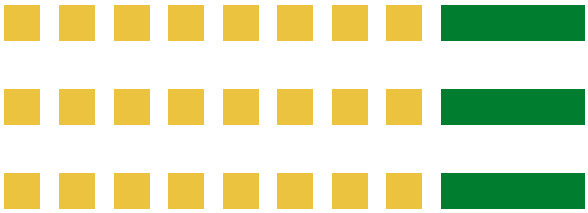


CONNECT IT

Use the problem from the previous page to help you understand how to use the distributive property to write equivalent expressions.

1. Look at the expressions $24 + 3d$ and $3(8 + d)$. Which expression is a sum of two terms? Which expression is a product of two factors?

2. The tiles in **Model It** are grouped to model the expression $24 + 3d$. The same set of tiles is shown at the right. Circle and label groups of tiles to show how the tiles also model the expression $3(8 + d)$.



3. Equivalent expressions always name the same value. How do the algebra tiles show that $24 + 3d$ and $3(8 + d)$ will always have the same value?

4. In **Analyze It**, the distributive property is used to rewrite the sum $24 + 3d$ as the product $3(8 + d)$. How do you use the distributive property to rewrite the product $3(8 + d)$ as the sum $24 + 3d$?

5. What are two ways you can use the distributive property to write equivalent expressions?

6. The distributive property applies to differences as well as sums. How could you use the distributive property to rewrite $6x - 6$ as a product?

7. **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to use the distributive property to write equivalent expressions.

Apply It

Use what you learned to solve these problems.

8 **a.** Use the distributive property to rewrite $(5x + 3)(2)$ as a sum of two terms. Show your work.

SOLUTION _____

b. You can use the commutative and associative properties of multiplication to reorder and regroup factors. Explain how you used one or both of these properties in your work for problem 8a.

9 Which expression is equivalent to $63 + 56$?

A $7(9 + 8)$

B $3(60 + 56)$

C $6(3 + 5)$

D $7(9 + 56)$

10 A company sells fruit cups in packs of 4. The packs currently weigh 20 oz. The company plans to reduce the weight of each cup by n oz. The expression $20 - 4n$ represents the new weight, in ounces, of a pack of fruit cups. Rewrite the expression for the new weight as a product of two factors. Show your work.

SOLUTION _____

Practice Using the Distributive Property to Write Equivalent Expressions

➤ **Study the Example showing how to use the distributive property to rewrite a product. Then solve problems 1–6.**

Example

Rewrite the expression $3(7a - 4b)$ as a difference.

You can use the distributive property to rewrite the product.

Multiply $7a$ and $4b$ by 3.	$3(7a - 4b)$
	$3 \cdot 7a - 3 \cdot 4b$
Use the associative property.	$(3 \cdot 7)a - (3 \cdot 4)b$
Multiply inside the parentheses.	$21a - 12b$

The difference $21a - 12b$ is equivalent to $3(7a - 4b)$.

1. You use the associative property of multiplication to change how factors are grouped. In the Example, why are the factors of the term $3 \cdot 7a$ regrouped as $(3 \cdot 7)a$?

2. Jesse says that the expressions $7(2x + 9)$ and $14x + 9$ are equivalent. Do you agree with Jesse? Explain.

3. Use the greatest common factor of 84 and 48 to write the sum $84 + 48$ as a product. Write a whole number in each blank.

$84 + 48$

_____ $\times (7 +$ _____$)$

Vocabulary

distributive property
for any numbers a, b, and c, $a(b + c) = ab + ac$.

equivalent expressions
two or more expressions in different forms that always name the same value.

greatest common factor (GCF)
the greatest factor two or more numbers have in common.

4 Rewrite the expression $2(3 - 4k)$ as a difference. Show your work.

SOLUTION

5 Tell whether each pair of expressions is *Equivalent* or *Not Equivalent*.

	Equivalent	Not Equivalent
a. $5(3t - 6)$ and $15t - 30$	○	○
b. $16 + 72n$ and $(2 + 9n)(8)$	○	○
c. $4(6a + 8b)$ and $10a + 12b$	○	○
d. $7x - 9y$ and $(7x - y)(9)$	○	○

6 Kaley plans to increase the amount of food she feeds her puppy each day by x oz. The expression $3x + 18$ represents the total weight of food, in ounces, Kaley will need for her puppy for the next three days.

a. Rewrite the expression as a product of two factors. Show your work.

SOLUTION

b. How many ounces of food did Kaley feed her puppy each day before she increased the amount? Explain how you know.

Develop Combining Like Terms

PAPER PLUS
Art Supply Store
RECEIPT

ITEM	AMOUNT
• gold tissue paper 2 large packages	$4.44
• blue tissue paper 3 small packages	$2.46
• green tissue paper 1 large package	$2.22
• purple tissue paper 2 small packages	$1.64
• pink tissue paper 4 sheets	$0.84

THANK YOU FOR SHOPPING IN OUR STORE!

➤ **Read and try to solve the problem below.**

Ryan is making papel picado as decorations for his aunt's wedding. The receipt shows how much tissue paper he bought. Each small package holds x sheets, and each large package holds y sheets. Write an expression with exactly three terms to represent the total number of sheets of tissue paper Ryan bought.

TRY IT

Math Toolkit algebra tiles, grid paper

DISCUSS IT

Ask: What does each term in your expression represent?

Share: The first term represents . . .

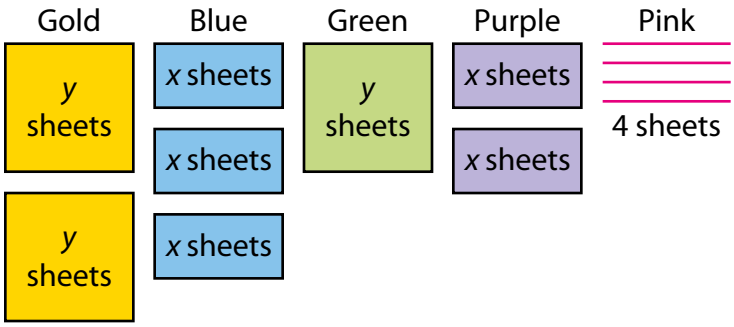
➤ **Explore different ways to combine like terms.**

Ryan is making papel picado as decorations for his aunt's wedding. The table shows how much tissue paper he bought. Each small package holds x sheets, and each large package holds y sheets. Write an expression with exactly three terms to represent the total number of sheets of tissue paper Ryan bought.

Paper Color	Amount
Gold	2 large packages
Blue	3 small packages
Green	1 large package
Purple	2 small packages
Pink	4 sheets

Picture It

You can draw a picture to help you write an algebraic expression.



$2y + 3x + y + 2x + 4$

Analyze It

You can use properties of operations to combine terms with the same variable parts.

Identify the **like terms**.	$2y + 3x + y + 2x + 4$
Reorder and regroup the terms.	$(2y + y) + (3x + 2x) + 4$
Rewrite the term y as $1y$.	$(2y + 1y) + (3x + 2x) + 4$
Use the distributive property with each pair of like terms.	$(2 + 1)y + (3 + 2)x + 4$

Papel picado

CONNECT IT

➤ **Use the problem from the previous page to help you understand how to combine like terms.**

1. Look at **Picture It**. How do the shapes show that an expression for the total number of sheets of tissue paper will have at least three terms?

2. Look at the four equivalent expressions in **Analyze It**.

   a. What are the like terms in the expression $2y + 3x + y + 2x + 4$? Explain.

   b. The commutative property of addition lets you reorder terms. How is this property used to rewrite the expression?

   c. Look at the last expression. Why can you use the distributive property to combine like terms?

3. What expression with exactly three terms can you write to represent the total number of sheets of tissue paper Ryan bought? How are the coefficients of the variable terms related to the coefficients of the variable terms of the original expression?

4. **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to combine like terms of an algebraic expression.

Apply It

Use what you learned to solve these problems.

5 Write an expression equivalent to $12g - 3g + 7$ with exactly two terms. Show your work.

SOLUTION

6 Which expressions are equivalent to $6a - a + 4b$? Select all that apply.

A $10b$

B $9ab$

C $6 + 4b$

D $5a + 4b$

E $(6 - 1)a + 4b$

F $(6 \cdot 1)a + 4b$

7 An athletic store receives an order for 8 blue jerseys, 12 pairs of blue shorts, 10 gold jerseys, and 5 pairs of gold shorts. Each jersey weighs j oz, and each pair of shorts weighs s oz. They are packed in a box that weighs 16 oz when empty. Write an expression with exactly three terms for the total weight, in ounces, of the box. Show your work.

Item	Quantity
blue jersey	8
blue shorts	12
gold jersey	10
gold shorts	5

SOLUTION

Practice Combining Like Terms

➤ **Study the Example showing how to combine like terms. Then solve problems 1–6.**

Example

The Woodworking Club is selling picture frames at the school craft fair. The frames sell for $11 each. Materials for each frame cost $6, and renting a booth costs $36. The expression $11f - 6f - 36$ represents the amount of money the club will make for selling f frames. Rewrite the expression with exactly two terms.

You can use the distributive property to combine like terms.

The terms $11f$ and $6f$ are like terms because both have the variable f.

$11f - 6f - 36$

$(11 - 6)f - 36$

$5f - 36$

The terms of $5f - 36$ are not like terms, so they cannot be combined.

The equivalent expression is $5f - 36$.

1 Look at the Example. Suppose the club increases the selling price of a frame to $13. Write an expression with exactly two terms for the amount of money the club will make for selling f frames. Show your work.

SOLUTION

2 Which expression is equivalent to $3a + 9a + 7b - b$?

A $12a + 7$

B $12a + 6b$

C $18ab$

D $19a$

Vocabulary

equivalent expressions
two or more expressions in different forms that always name the same value.

like terms
two or more terms that have the same variable factors.

perimeter
the distance around a two-dimensional shape.

3 Neena and Carissa collect trading cards. Neena has 4 packs of castle cards and 5 packs of hero cards. Carissa has 6 packs of castle cards and 4 packs of hero cards. Each castle pack holds c cards, and each hero pack holds h cards. Write an expression with exactly two terms for the total number of cards Neena and Carissa have. Show your work.

SOLUTION

4 Write a whole number in each blank to show an expression that is equivalent to $15x + 10$.

$20x - \_\_\_\_\_ \cdot x + \_\_\_\_\_$

5 Isaiah writes an expression with 5 terms. All 5 terms are like terms. How many terms are in the equivalent expression with the least number of terms? Explain.

6 The length of a rectangle is twice the width w. Which expressions represent the perimeter of the rectangle? Select all that apply.

A $2w + w + 2w + w$

B $2w + 2(2w)$

C $2(w + 2w)$

D $2(2w)$

E $6w$

Develop Identifying Equivalent Expressions

➤ **Read and try to solve the problem below.**

Which of these three expressions are equivalent?

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

TRY IT

Math Toolkit algebra tiles, grid paper

DISCUSS IT

Ask: What is another way you could show which expressions are equivalent?

Share: I could also . . .

➤ **Explore different ways to identify equivalent expressions.**

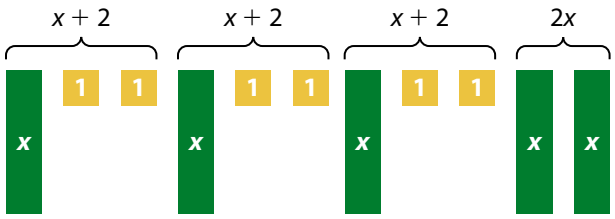
Which of these three expressions are equivalent?

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

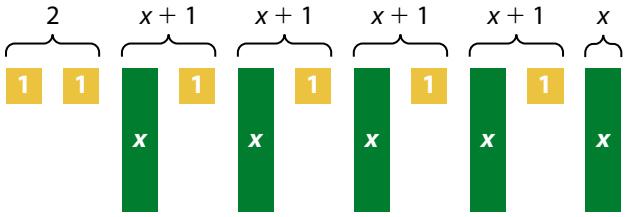
Model It

You can use algebra tiles to model each expression.

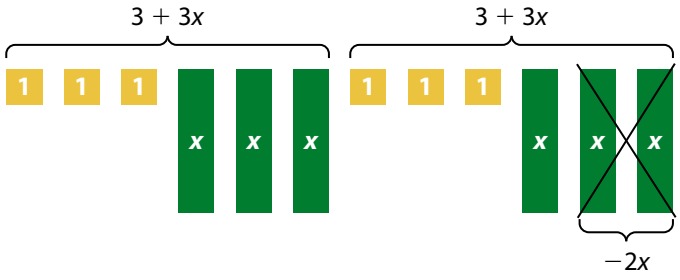
$3(x + 2) + 2x$



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



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



Analyze It

You can use properties of operations to write each expression without parentheses and with the fewest number of terms possible.

$3(x + 2) + 2x$	$2 + 4(x + 1) + x$	$2(3 + 3x) - 2x$
$3 \cdot x + 3 \cdot 2 + 2x$	$2 + 4 \cdot x + 4 \cdot 1 + x$	$2 \cdot 3 + 2 \cdot 3x - 2x$
$3x + 6 + 2x$	$2 + 4x + 4 + x$	$6 + 6x - 2x$
$(3x + 2x) + 6$	$(2 + 4) + (4x + x)$	$6 + (6x - 2x)$
$5x + 6$	$6 + 5x$	$6 + 4x$

CONNECT IT

Use the problem from the previous page to help you understand how to identify equivalent expressions.

1. Look at **Model It**. How do you use tiles to model $3(x + 2) + 2x$?

2. How could rearranging the algebra tiles help you determine which expressions are equivalent?

3. Look at the first group of expressions in **Analyze It**. List the properties of operations that are used to rewrite the expression $3(x + 2) + 2x$.

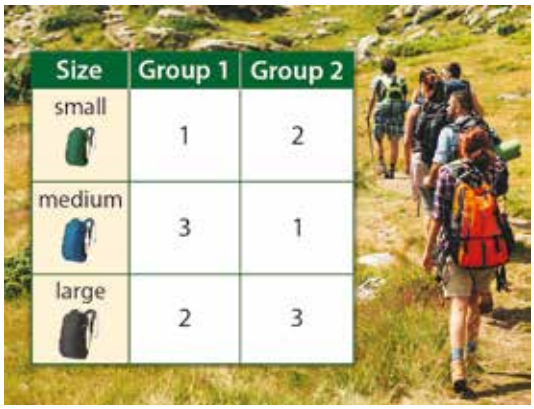
4. Which of the three expressions are equivalent? Explain how you know.

5. How are properties of operations useful for identifying equivalent expressions?

6. **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to solve the **Try It** problem.

Apply It

Use what you learned to solve these problems.



7 Two groups of campers carry their water in reusable packs that come in three sizes. The table shows how many packs each group carries. A medium water pack holds 1 liter more than a small pack holds. A large pack holds 2 liters more than a small pack. Do the two groups carry the same amount of water? If not, which group carries more? Use w to represent the number of liters of water a small pack can hold. Show your work.

SOLUTION

8 Which expressions are equivalent to $8a - 6$? Select all that apply.

A $5a + 6 - 3a$

B $2a + 6(a - 1)$

C $4a + 2(2a - 3)$

D $2 + 3a + 3(a - 2)$

E $11a - a + 2(a - 3)$

9 Are the expressions $3(x + y) + 2y + 10$ and $x + 5y + 2(x + 5)$ equivalent? Show your work.

SOLUTION

Practice Identifying Equivalent Expressions

➤ **Study the Example showing how to determine whether expressions are equivalent. Then solve problems 1–5.**

Example

Are the expressions $4(x + 1) - 1$ and $2(x + 1) + 2x$ equivalent?

You can use properties of operations to rewrite the expressions.

$4(x + 1) - 1$	$2(x + 1) + 2x$
$4 \cdot x + 4 \cdot 1 - 1$	$2 \cdot x + 2 \cdot 1 + 2x$
$4x + 4 - 1$	$2x + 2 + 2x$
$4x + (4 - 1)$	$(2x + 2x) + 2$
$4x + 3$	$4x + 2$

No matter what the value of x is, $4x + 3$ will always be 1 more than $4x + 2$. The expressions $4x + 3$ and $4x + 2$ never name the same value.

The expressions $4(x + 1) - 1$ and $2x + 2(x + 1)$ are not equivalent.

1 Explain how the distributive property and the commutative property of addition are used in the Example to show that $2(x + 1) + 2x$ is equivalent to $4x + 2$.

2 Is each expression equivalent to the expression $48a - 36b$? Select *Yes* or *No* for each expression.

	Yes	No
a. $30(18a - 6b)$	○	○
b. $12a + 36(a - b)$	○	○
c. $12(3a + a - 3b)$	○	○
d. $4(10a + 2a - 9b)$	○	○

Vocabulary

equivalent expressions
two or more expressions in different forms that always name the same value.

term
a number, a variable, or a product of numbers, variables, and/or expressions.

Corn maze

3 An adult ticket to a corn maze costs $4 more than a child ticket. A senior ticket costs $3 more than a child ticket. Amelia's family has 3 children and 2 adults. Manuel's family has 2 children, 1 adult, and 2 seniors. Do the two families pay the same amount for tickets to the maze? If not, who pays more? Use c to represent the cost of a child ticket. Show your work.

SOLUTION

4 You can use the commutative property to reorder the terms of an expression. James says that you can use the commutative property to rewrite $5m + 10$ as $10m + 5$. Is James correct? Explain.

5 Which of these three expressions are equivalent? Show your work.

$7(2 + 3x) - 3x$ $2(6x + 7) + 10x$ $4(3 + 3x) + 2(1 + 3x)$

SOLUTION

Refine Writing and Identifying Equivalent Expressions

➤ **Complete the Example below. Then solve problems 1–10.**

Example

Are the expressions $(3x)(x) + 6$ and $x + x + 6 + x$ equivalent?

Look at how you could rewrite the expressions to compare them.

$(3x)(x) + 6$	$x + x + 6 + x$
$3(x \cdot x) + 6$	$(x + x + x) + 6$
$3x^2 + 6$	$3x + 6$

SOLUTION _____

CONSIDER THIS . . .
Are the terms $3x^2$ and $3x$ like terms? Why or why not?

PAIR/SHARE
Explain how you know whether the expressions are equivalent.

Apply It

1 The fine for an overdue library book is \$0.75 for the first day and \$0.50 for each additional day. Rewrite the expression $0.75 + 0.5(d - 1)$ for the fine as a sum of two terms where d represents the number of days overdue. Show your work.

CONSIDER THIS . . .
How could you use the distributive property to rewrite the expression?

PAIR/SHARE
What would the fine be for a book that is 4 days overdue?

SOLUTION _____

2 Ana and Katrina are buying fruit to bring to their book club meeting. Ana buys 2.4 lb of oranges and 0.8 lb of cherries. Katrina buys 1.8 lb of oranges and 1.3 lb of cherries. Oranges cost r dollars per pound, and cherries cost c dollars per pound. Write an expression with exactly two terms for the total cost of the fruit Ana and Katrina buy. Show your work.

CONSIDER THIS . . .
The cost of Ana's oranges is equal to the weight of her oranges times the cost per pound.

PAIR/SHARE
What does each term in your expression represent?

SOLUTION

3 Which expression is equivalent to $3(2x + 4y) - y$?

A $17xy$

B $6x + 12$

C $3(6xy) - y$

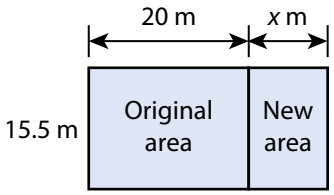
D $6(x + 2y) - y$

Kimani chose C as the correct answer. How might she have gotten that answer?

CONSIDER THIS . . .
How can you use properties of operations to rewrite $3(2x + 4y) - y$ in a different way?

PAIR/SHARE
How could you use $x = 1$ and $y = 2$ to check your answer?

4 A park meadow is planted with wildflowers. The Parks Department plans to extend the length of the rectangular meadow by x meters. Which expressions represent the total area, in square meters, after the meadow's length is increased? Select all that apply.



A $310 + x$

B $15.5(20x)$

C $20x + 15.5$

D $15.5x + 310$

E $15.5(20 + x)$

F $35.5 + x$

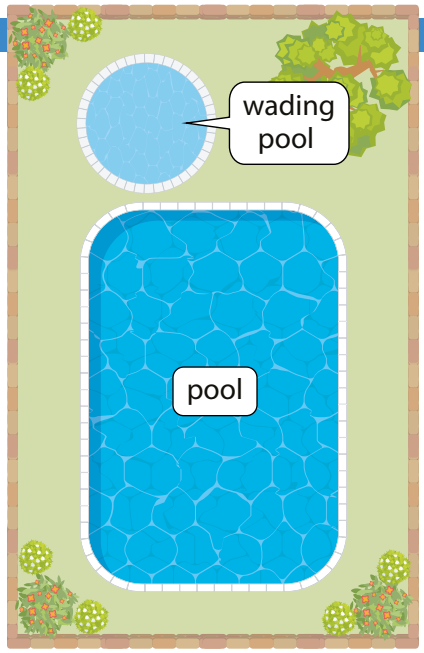
5 Use the distributive property to write two different expressions equal to 72. Each expression should be the product of a number and a sum. Show your work.

SOLUTION

6 Look at each pair of expressions. Select *Equivalent* or *Not Equivalent* for each pair.

	Equivalent	Not Equivalent
a. $f + f + f$ and $3f$	○	○
b. $x^2 + 3y$ and $(x + x) + y \cdot y \cdot y$	○	○
c. $2.5(2n - 4)$ and $5n - 4$	○	○

7 Show how to use the greatest common factor of 84 and 72 to rewrite $84m - 72n$ as a product of two factors. Label the step that shows the distributive property.



8 A wading pool holds g gallons of water. A swimming pool holds 15 times as much water as the wading pool. Which expressions represent the total number of gallons of water in both pools? Select all that apply.

A $15g$

B $16g$

C $15 + g$

D $2g + 15$

E $g + 15g$

9 Are the expressions $\frac{1}{2}(4c + 8) + 3c - 2$ and $4c + 2(0.5c + 1)$ equivalent? Show your work.

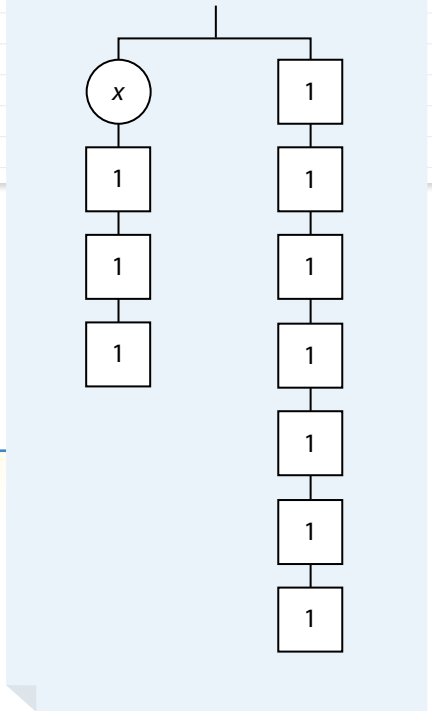
SOLUTION

10 **Math Journal** Brian says that the expressions $2(x + 2)$ and $3(x + 1) + 1$ are equivalent because they name the same value when $x = 0$. Is Brian's reasoning correct? Explain.

End of Lesson Checklist

- ☐ **INTERACTIVE GLOSSARY** Find the entry for *like terms*. Explain why the terms $5a$ and $5b$ in the expression $5a + 5b + 8$ are not like terms. Label your explanation as a non-example.
- ☐ **SELF CHECK** Go back to the Unit 5 Opener and see what you can check off.

Explore One-Variable Equations



Previously, you learned about solutions of equations. In this lesson, you will learn how to solve addition and multiplication equations in one variable.

➤ **Use what you know to try to solve the problem below.**

What is the value of x in the hanger diagram? How do you know?

TRY IT

Math Toolkit algebra tiles, counters, grid paper

DISCUSS IT

Ask: How can you verify that you found the correct value of x?

Share: I know my answer makes sense because . . .

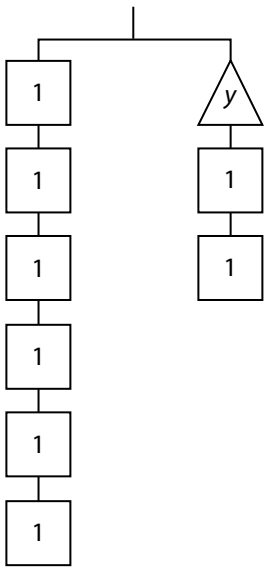
Learning Target **SMP 1, SMP 2, SMP 3, SMP 4, SMP 5, SMP 6**

Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers.

CONNECT IT

1 Look Back What is the value of x in the hanger diagram? Explain how you could find the value of x.

2 Look Ahead Use the hanger diagram.



a. What expression does the left side of the hanger represent? What expression does the right side of the hanger represent?

b. The hanger is balanced. What does that tell you about the two expressions you wrote in problem 2a? What equation does the hanger diagram represent?

c. Draw two more 1s on each side of the hanger. Why is the hanger still balanced? What equation does the hanger represent now?

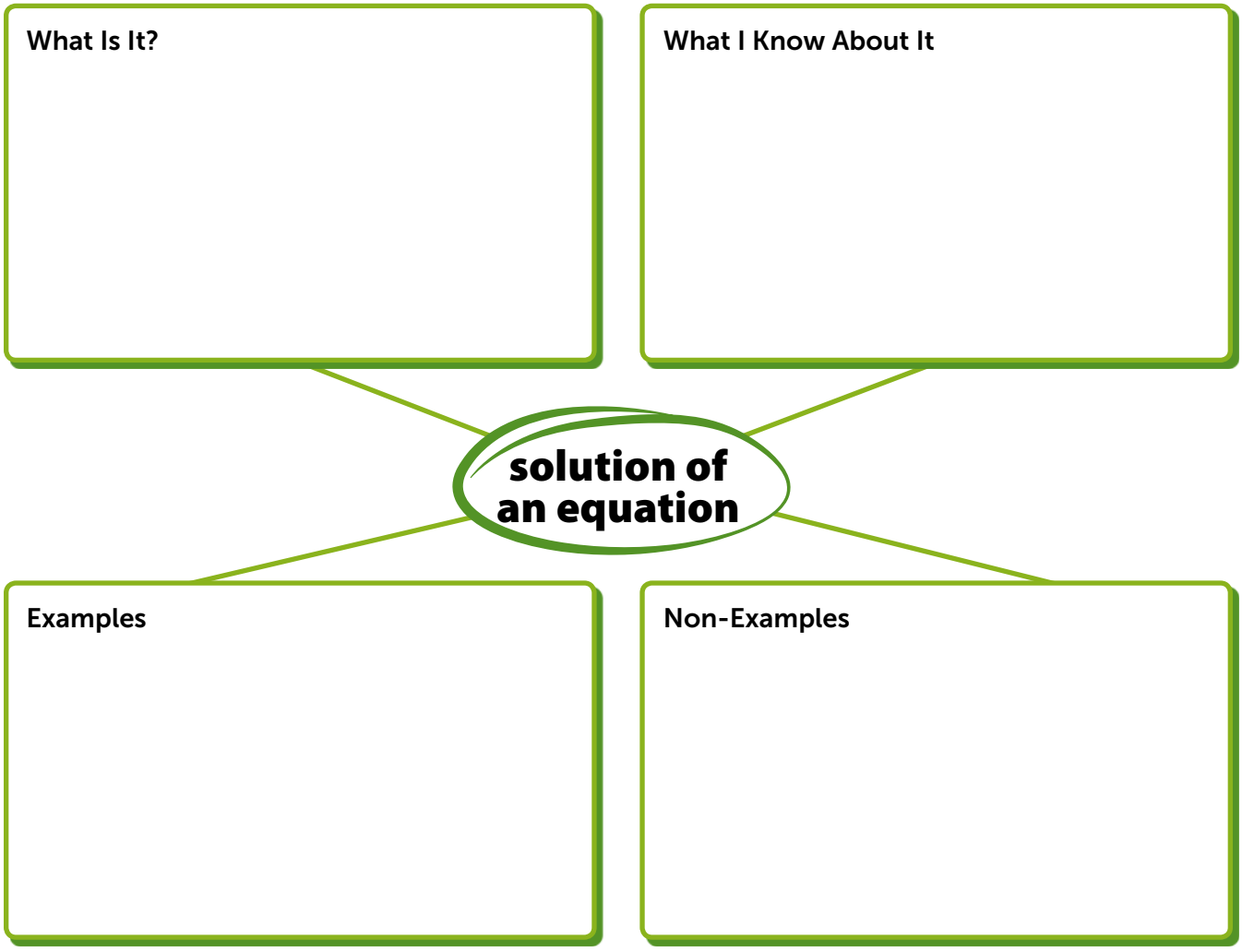
d. Suppose you remove three 1s from the right side of the hanger. What should you do to keep the hanger balanced?

3 Reflect To keep a hanger diagram balanced, what must you do when adding and removing amounts on the sides of the hanger? Why?

 Name:

Prepare for Writing and Solving One-Variable Equations

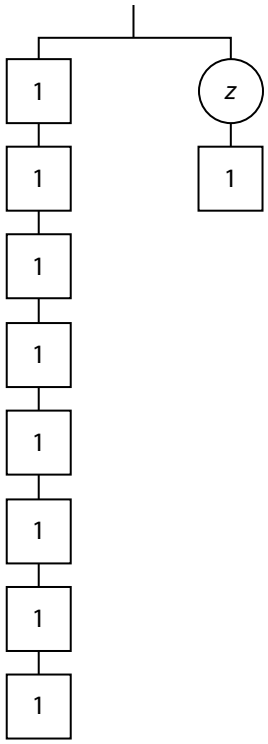
1 Think about what you know about solutions of equations. Fill in each box. Use words, numbers, and pictures. Show as many ideas as you can.



2 Circle the equations for which 6 is a solution of the equation.

$4 = x + 2$	$y - 2 = 4$	$6z = 36$	$12 \div w = 6$
$x + 2 = 6$	$56 = 5y$	$8 + z = 14$	$2 = \frac{w}{12}$

3 Look at the hanger diagram.



a. What is the value of z in the hanger diagram? Show your work.

SOLUTION _____

b. Check your answer to problem 3a. Show your work.

Develop Solving One-Variable Addition Equations

➤ **Read and try to solve the problem below.**

An animal rescue group in Africa is taking care of 5 injured baby pixie frogs. They plan to release them back into the wild when they are healthy. Each pixie frog needs its own terrarium. One of the rescue volunteers checks and sees that there are only 3 terrariums. Solve the equation $t + 3 = 5$ to find how many more terrariums, t, the rescue center needs.

TRY IT

Math Toolkit algebra tiles, counters, grid paper

DISCUSS IT

Ask: What did you do first to solve the problem?

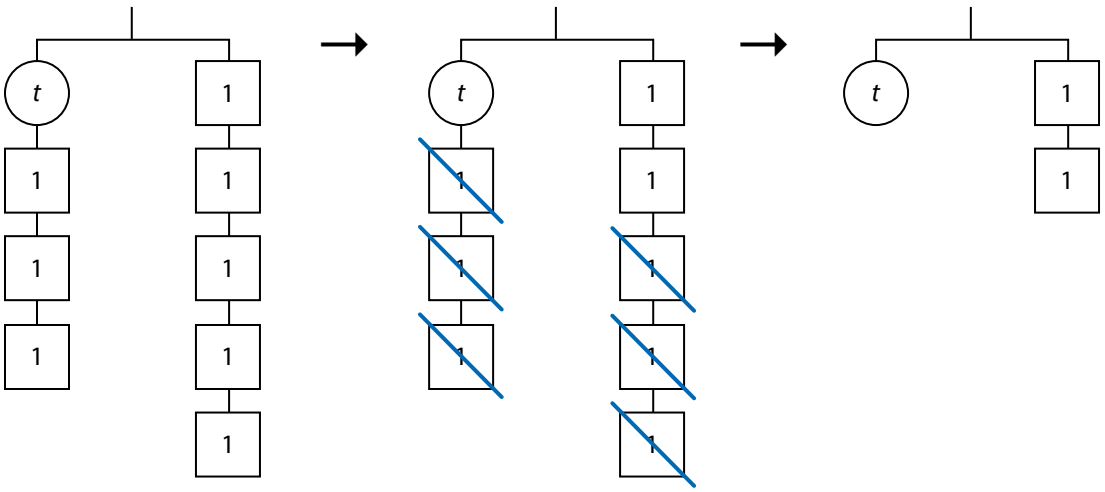
Share: The first thing I did was . . .

➤ **Explore different ways to solve a one-variable addition equation.**

An animal rescue group in Africa is taking care of 5 injured baby pixie frogs. They plan to release them back into the wild when they are healthy. Each pixie frog needs its own terrarium. One of the rescue volunteers checks and sees that there are only 3 terrariums. Solve the equation $t + 3 = 5$ to find how many more terrariums, t, the rescue center needs.

Model It

You can use a hanger diagram to model and solve an addition equation.



Analyze It

You can use subtraction to solve for a variable in an addition equation.

$$t + 3 = 5$$

$t + 3 - 3 = 5 - 3$ ← **Subtract 3** from both sides of the equation.

$$t = 2$$

CONNECT IT

Use the problem from the previous page to help you understand how to solve a one-variable addition equation.

1. Look at **Model It**. Why are three 1s removed from each side of the hanger diagram?

2. Look at **Analyze It**. How are the steps for solving the equation similar to the steps for solving the equation with the hanger diagram?

3. How many more terrariums does the rescue center need? How can you use substitution to verify that your answer is correct?

4. How are all the equations below similar to $t + 3 = 5$? Why could you solve each equation by subtracting a number from both sides of the equation?

   $8 + y = 92$ $\quad 50 = a + 17$ $\quad n + 2.2 = 5$ $\quad 12.5 = 7.4 + z$

5. **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to solve one-variable addition equations.

Apply It

Use what you learned to solve these problems.

6 Teresa has some photos on her computer on Monday. On Tuesday, she downloads 24 new photos. Then she deletes 9 photos. She ends up with 33 photos. Explain how the equation $p + 24 - 9 = 33$ represents the situation. Then solve the equation for the variable p and interpret the solution.

7 What is the solution of the equation $7 + 5 = 4 + y$?

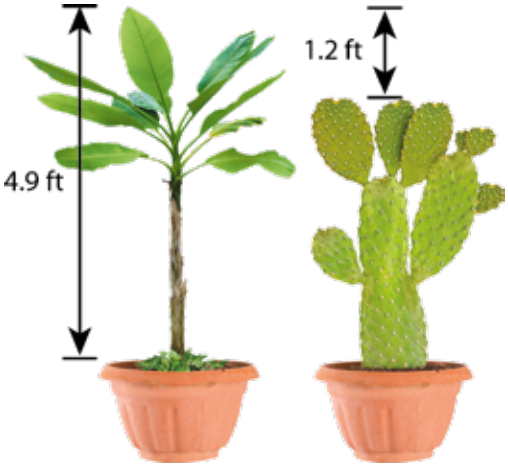
A 6

B 8

C 12

D 16

8 At a local gardening store, a palm tree is 1.2 ft taller than a cactus. The palm tree is 4.9 ft tall. Use the equation $4.9 = c + 1.2$ to find the height in feet, c, of the cactus. Show your work.



SOLUTION

Practice Solving One-Variable Addition Equations

➤ **Study the Example showing how to solve a one-variable addition equation. Then solve problems 1–5.**

Example

Cameron buys a stapler. Then he buys 5 notebooks that cost $1.50 each. He spends $13.50 in all. Use the equation $d + 5(1.50) = 13.50$ to find the number of dollars, d, that Cameron spends on the stapler.

	$d + 5(1.50) = 13.50$
Multiply 1.50 by 5.	$d + 7.50 = 13.50$
Subtract 7.50 from both sides.	$d + 7.50 - 7.50 = 13.50 - 7.50$
	$d = 6$

Cameron spends $6 on the stapler.

1 **a.** In the Example, why is 7.50 subtracted from both sides of the equation?

b. Why can you replace the expression $d + 7.50 - 7.50$ with just the variable d in the last step of solving the equation?

2 Solve the equation $91 = 43 + x$. Show your work.

SOLUTION _____

3 On Monday, Jessica runs on a track at her school. Each day from Tuesday through Friday, she runs $1\frac{1}{2}$ mi in a park. The total distance she runs for the week is 8 mi. Solve the equation $m + 4\left(1\frac{1}{2}\right) = 8$ to find the number of miles, m, Jessica runs on Monday. Show your work.

SOLUTION

4 What operation can you use on both sides of the equation $100 = 100 + y$ to solve the equation for y? Solve the equation for y. Then explain how to check the solution.

5 Dylan has a pitcher with 1.65 L of orange juice. He pours out 0.2 L of the juice. Then he adds some sparkling water to the pitcher to make orangeade. He ends up with 1.9 L of orangeade. Solve the equation $1.65 - 0.2 + x = 1.9$ to find the amount of sparkling water, x, Dylan adds to the pitcher. Show your work.

SOLUTION

Develop Solving One-Variable Multiplication Equations

➤ **Read and try to solve the problem below.**

Tamera is buying party favors. She chooses pencil erasers that are shaped like pieces of sushi. Each package she buys contains the same number of erasers. She buys 2 packages and gets a total of 8 erasers. Solve the equation $2x = 8$ to find the number of erasers, x, in each package.

TRY IT

Math Toolkit algebra tiles, counters, grid paper

DISCUSS IT

Ask: How is your strategy similar to mine? How is it different?

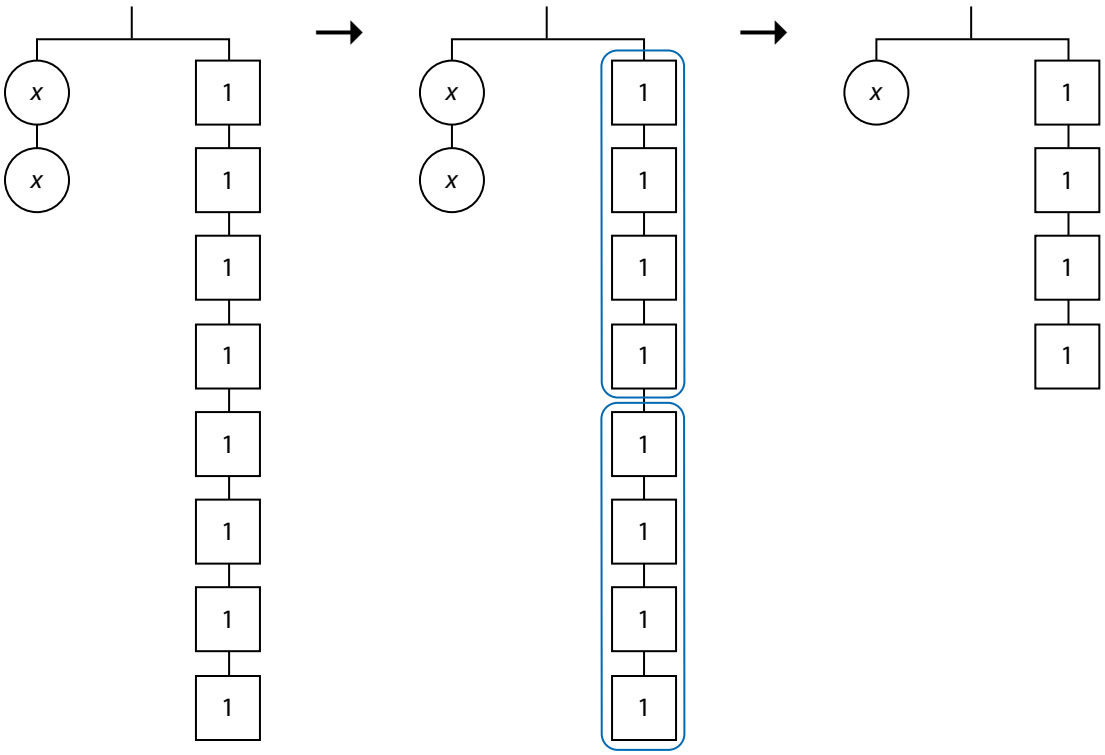
Share: My strategy is similar because . . . It is different because . . .

➤ **Explore different ways to solve a one-variable multiplication equation.**

Tamera is buying party favors. She chooses pencil erasers that are shaped like pieces of sushi. Each package she buys contains the same number of erasers. She buys 2 packages and gets a total of 8 erasers. Solve the equation $2x = 8$ to find find the number of erasers, x, in each package

Model It

You can use a hanger diagram to model and solve a multiplication equation.



Analyze It

You can use division to solve for a variable in a multiplication equation.

$2x = 8$

$\frac{2x}{2} = \frac{8}{2}$ ← **Divide** both sides of the equation **by 2**.

$x = 4$

CONNECT IT

Use the problem from the previous page to help you understand how to solve a one-variable multiplication equation.

1. Look at the second hanger diagram in **Model It**. Why are the 1s separated into two equal groups?

2. Look at **Analyze It**. Why can you use the fractions $\frac{2x}{2}$ and $\frac{8}{2}$ to show dividing both sides of the equation $2x = 8$ by 2?

3. How are the steps for solving the equation similar to the steps for solving the problem with the hanger diagram?

4. How many erasers are in each package? How you can use substitution to check your answer?

5. How is solving $2x = 8$ similar to solving $2 + x = 8$? How is it different?

6. **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand solving one-variable multiplication equations.

Apply It

Use what you learned to solve these problems.

7 Four friends go on a camping trip. They decide to share the cost equally. They spend $27.68 on food and $42 to reserve the campsite. You can use the equation $4c = 42 + 27.68$ to find each person's share of the cost.

a. What does the variable c represent? Explain how the equation $4c = 42 + 27.68$ represents the situation.

b. Solve the equation for c and interpret the solution. Show your work.

SOLUTION _____

8 What is the solution of the equation $12\left(\frac{1}{2}\right)y = 2$?

A $\frac{1}{6}$ **B** $\frac{1}{3}$

C 3 **D** 6

9 Benjamin ran a total of 21 miles last month. This is 75% of the number of miles he wants to run this month. Solve the equation $0.75m = 21$ to find out how many miles, m, Benjamin wants to run this month. Show your work.

SOLUTION _____

Practice Solving One-Variable Multiplication Equations

➤ **Study the Example showing how to solve a one-variable multiplication equation. Then solve problems 1–5.**

Example

Mariko is making potato pancakes. She has $4\frac{3}{4}$ lb of shredded potatoes. She uses $\frac{1}{4}$ lb to make each pancake. Solve the equation $4\frac{3}{4} = \frac{1}{4}p$ to find the number of potato pancakes, p, Mariko can make.

You can divide by the coefficient of the variable to solve the equation for p.

$$4\frac{3}{4} = \frac{1}{4}p$$

$$4\frac{3}{4} \cdot 4 = \frac{1}{4}p \cdot 4 \quad \leftarrow \text{To divide by } \frac{1}{4}\text{, multiply by the reciprocal, 4.}$$

$$\frac{19}{4} \cdot \frac{4}{1} = p$$

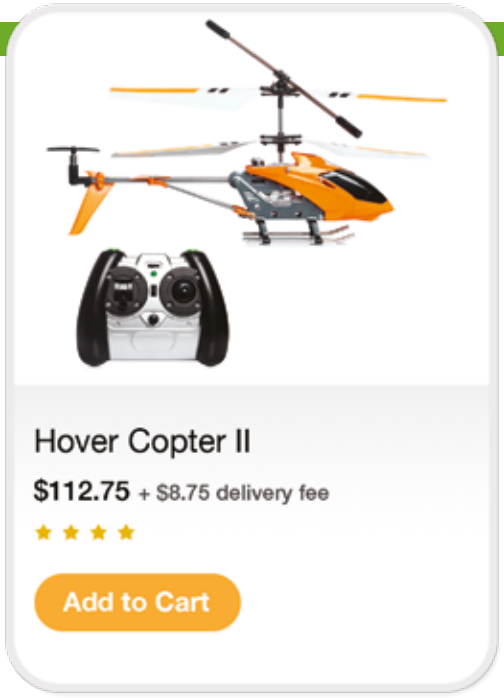
$$19 = p$$

Mariko can make 19 potato pancakes.

1. In the Example, why can you replace the expression $\frac{1}{4}p \cdot 4$ on the right side of the equation with just the variable p?

2. Mindy has a piece of string that is $5\frac{1}{2}$ yd long. She cuts it into pieces that are each $\frac{1}{2}$ yd long. Solve the equation $5\frac{1}{2} = \frac{1}{2}x$ to find out how many pieces of string, x, she gets. Show your work.

SOLUTION _____



3 Khalid plans to save the same amount of money each month for 6 months to buy a remote control helicopter.
The helicopter costs $112.75 plus $8.75 for delivery. Khalid has a coupon for $18 off the price of the helicopter.

a. Use the equation $6m = 112.75 - 18 + 8.75$ to find out how much money, m, Khalid should save each month. Show your work.

SOLUTION

b. How much money would Khalid need to save each month if he did not have the $18 coupon? Explain your reasoning.

4 What operation would you use to solve $10 = 6y$? Explain your reasoning.

5 A can of tomato sauce contains 8 oz of sauce. A case contains 12 cans.
Chef Hugo orders some cases of tomato sauce and gets a total of 480 oz of sauce. Use $12(8)x = 480$ to find out how many cases of tomato sauce Chef Hugo orders, x. Show your work.

SOLUTION

Develop Writing and Solving One-Variable Equations

➤ **Read and try to solve the problem below.**

A dance crew is entering a hip-hop dance contest with a short routine and a long routine. The combined length of the two routines must be 16 min. The crew's long routine is 3 times as long as the short routine. Write and solve an equation to find the lengths of the crew's two routines.

TRY IT

Math Toolkit algebra tiles, grid paper, number lines

DISCUSS IT

Ask: What does each side of your equation represent?

Share: The left side of my equation shows . . . The right side of my equation shows . . .

➤ **Explore different ways to write and solve a one-variable equation.**

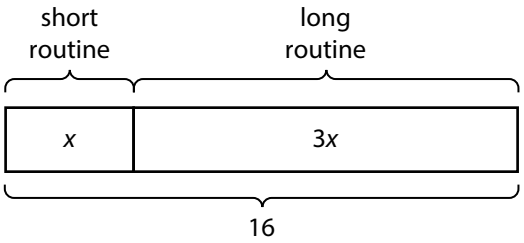
A dance crew is entering a hip-hop dance contest with a short routine and a long routine. The combined length of the two routines must be 16 min. The crew's long routine is 3 times as long as the short routine. Write and solve an equation to find the lengths of the crew's two routines.

Model It

You can use a bar model to show how the quantities in the problem are related.

Let x be the length of the short routine in minutes.

Then the length of the long routine in minutes is $3x$.



Model It

You can use words to help you write an equation with a variable.

The combined length of the two routines is 16 min.

length of short routine	+	length of long routine	=	total length of routines
↓		↓		↓
x	+	$3x$	=	16

Analyze It

You can use equivalent expressions and an inverse operation to solve an equation.

$$x + 3x = 16$$

$$4x = 16$$

$$\frac{4x}{4} = \frac{16}{4}$$

$$x = ?$$

CONNECT IT

Use the problem from the previous page to help you understand how to write and solve a one-variable equation.

1. Look at the two **Model Its**. How are they similar?

2. How do the two **Model Its** help you write an equation?

3. Look at the first two equations in **Analyze It**. Why can you replace expression $x + 3x$ with the expression $4x$? Why is this step necessary?

4. What are the lengths of the crew's routines? How you can use substitution to check your answer?

5. How can writing and solving an equation help you solve a real-world problem?

6. **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to solve the **Try It** problem.

Apply It

Use what you learned to solve these problems.

7 Tyler sells popcorn at the movies. He arrives at work and sees there are some kernels in the popcorn bin. He pours in 4 more cups of kernels to fill the bin. Then he removes 1.5 cups of kernels. Now there are 6 cups of kernels in the bin. Write and solve an equation to find out how many cups of kernels were in the bin when Tyler arrived. Show your work.

SOLUTION

8 Colin has 17 fewer baseball cards than Demi. Demi has 28 cards. Which equations can you use to find n, the number of baseball cards Colin has? Select all that apply.

A $n = 28 - 17$

B $28 = n + 17$

C $17 = 28 - n$

D $n = 17 + 28$

E $n - 17 = 28$

F $17 = n - 28$

9 Gabe mails two packages. One package weighs $\frac{3}{4}$ as much as the other package. The total weight of the packages is 7 lb. Write and solve an equation to find the weights of the two packages. Show your work.

SOLUTION

Practice Writing and Solving One-Variable Equations

➤ **Study the Example showing how to write and solve a one-variable equation. Then solve problems 1–5.**

Example

At the grocery store, Samuel spends $9 on fruits and vegetables. This is 80% of the money he spends in all. How much does Samuel spend?

Let m = the amount in dollars that Samuel spends.

Write an equation.

80% of the money Sam spends is $9.

$0.8 \cdot m = 9$

Solve the equation for m.

$0.8m = 9$

$\frac{0.8m}{0.8} = \frac{9}{0.8}$

$m = 11.25$

Samuel spends $11.25.

1 There are 12 paperback mysteries on a shelf. This is 40% of the books on the shelf. Write and solve an equation to find the number of books on the shelf. Show your work.

SOLUTION _____

2 Three friends play a game. Jamila has $4\frac{1}{2}$ more points than Carter. Carter has $7\frac{1}{2}$ more points than Aisha. Jamila has 26 points. Write and solve an equation to find the number of points Aisha has. Show your work.

SOLUTION _____

3 At a theme park, the waiting time for the roller coaster is usually 3 times as long as the waiting time for the bumper cars. The park's website says that visitors who go on both rides should expect to wait a total of 30 min. What is the usual waiting time for the bumper cars? Show your work.

SOLUTION _____

4 The length of a rectangle is twice its width. The perimeter of the rectangle is 36 ft. What are the length and width of the rectangle? Show your work.

SOLUTION _____

5 Neva is training for a race. This week, she bikes 5.5 times as far as she runs. Her total distance running and biking this week is 26 mi. How far does Neva run this week? Show your work.

SOLUTION _____

Refine Writing and Solving One-Variable Equations

➤ **Complete the Example below. Then solve problems 1–9.**

Example

At Valley Middle School, $\frac{3}{5}$ of the students study Spanish. There are 96 students who study Spanish. Solve the equation $\frac{3}{5}n = 96$ to find the number of students, n, at the school.

Look at how you could multiply by the reciprocal to solve a multiplication equation.

$$\frac{3}{5}n = 96$$

$$\frac{5}{3} \cdot \frac{3}{5}n = \frac{5}{3} \cdot 96$$

$$1 \cdot n = \frac{5 \cdot 96}{3}$$

$$n = 5 \cdot 32$$

SOLUTION _____

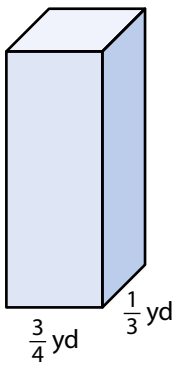
CONSIDER THIS . . .
The product of a number and its reciprocal is 1.

PAIR/SHARE
Why is $\frac{5 \cdot 96}{3}$ equivalent to $5 \cdot 32$?

Apply It

1 The volume of the right rectangular prism is $\frac{1}{2}$ yd^3.

What is the height of the prism? Show your work.



SOLUTION _____

CONSIDER THIS . . .
The formulas for the volume of a right rectangular prism are $V = \ell wh$ and $V = Bh$.

PAIR/SHARE
How can you verify that your answer is correct?

2 Yukio has a checking account. On Monday, he writes 3 checks for $65 each. His balance at the end of the day is $330.25. Use an equation with a variable to find Yukio's balance at the start of the day. Show your work.

CONSIDER THIS . . .
When writing checks, your account balance decreases.

PAIR/SHARE
How can you use estimation to make sure your answer is reasonable?

SOLUTION

3 Carmen and Erin collect cans of food for a food drive. Carmen collects 5 times as many cans of food as Erin. Together, they collect 60 cans of food. Which equation can you solve to find the number of cans of food Erin collects?

A $5x = 60$

B $6x = 60$

C $\frac{1}{5}x = 60$

D $x = 60 \cdot 5$

Jelani chose B as the correct answer. How might he have gotten that answer?

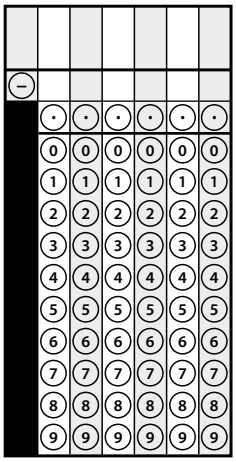
CONSIDER THIS . . .
You can write an equation where one side is an algebraic expression for the total number of cans of food Carmen and Erin collect.

PAIR/SHARE
How can you find the number of cans of food Carmen collects?

4 Ju-long has 6 guppies in his aquarium. This is 24% of the fish in the aquarium. How many fish are in Ju-long's aquarium? Use an equation with a variable. Show your work.

SOLUTION

5 What is the solution of the equation $9\frac{1}{3} = x + 9\frac{1}{3}$?



6 Consider the equation $\frac{2}{5}y = 20$. Tell whether each statement is *True* or *False*.

	True	False
a. You can solve the equation by multiplying both sides by $\frac{5}{2}$.	○	○
b. You can solve the equation by dividing both sides by $\frac{2}{5}$.	○	○
c. The equation has the same solution as $\frac{5}{2}y = 20$.	○	○
d. The equation has the same solution as $\frac{4}{5}y = 40$.	○	○

7 Each day from Monday to Friday, Enrico uses a rideshare scooter to take the same route to and from work. According to the rideshare app, the total distance he rides each week is 13 mi. Explain how to write an equation that Enrico can use to find the distance of one trip to or from work. Show how to solve the equation.

8 Is the value of w the same in both equations shown below? Explain how you can decide without solving the equations.

$w + 16 = 43$ $\qquad$ $w + 16 - 7 = 43 - 7$

9 **Math Journal** Write an equation that you can solve by subtracting 3.2 from both sides of the equation. Then show how to solve the equation and check your solution.

End of Lesson Checklist

- ☐ **INTERACTIVE GLOSSARY** Find the entry for *equation*. Add two important things you learned about equations in this lesson.
- ☐ **SELF CHECK** Go back to the Unit 5 Opener and see what you can check off.