Chapter 9
Properties and Equations

ESSENTIAL QUESTION
How are properties and equations used to group numbers?

Let's Work with Tools!

Watch a video!
3.OA.5 Apply properties of operations as strategies to multiply and divide.

3.OA.7 Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that $8 \times 5 = 40$, one knows $40 \div 5 = 8$) or properties of operations. By the end of Grade 3, know from memory all products of two one-digit numbers.

3.OA.8 Solve two-step word problems using the four operations. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

= focused on in this chapter
Algebra  Find each unknown.

1. $8 + \Box = 11$  
2. $\Box \times 5 = 20$  
3. $36 \div 6 = \Box$

The unknown is ____.  The unknown is ____.  The unknown is ____.

4. 15
5. 9

\[ \frac{15}{6} = \Box \]
\[ \frac{9}{27} = \Box \]

The unknown is ____.  The unknown is ____.  The unknown is ____.

7. Use the number sentence \[ 12 + 15 + \Box = 36 \] to find how many books Tony read in August.

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Books Read</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>12</td>
</tr>
<tr>
<td>July</td>
<td>15</td>
</tr>
<tr>
<td>August</td>
<td>__</td>
</tr>
</tbody>
</table>

The unknown is ____ books.

8. Circle the property which is represented by $6 + 5 = 5 + 6$.

- Associative Property of Addition
- Commutative Property of Addition
- Identity Property of Addition

9. Abia sold 1 more candle than Mel. Together, they sold 15 candles. Draw a picture that shows how many candles they each sold.

10. Daniela spent $20 at the grocery store and $15 at the gas station. How much did she spend in all? Write a number sentence with a symbol for the unknown. Solve.


Review Vocabulary

array  decompose  equals sign (\(=\))  known fact  unknown

Making Connections
Label each section of the flow chart with the correct review vocabulary word.

\[4 \times 7 = 28\]

\[2 \times 7 = 14\]
**Associative Property of Multiplication**

\[ 3 \times (2 \times 4) = (3 \times 2) \times 4 \]

\[ 3 \times 8 = 6 \times 4 \]

\[ 24 = 24 \]

**Distributive Property**

\[ 4 \times 8 = (4 \times 6) + (4 \times 2) \]

**equation**

\[ 21 \div 7 = 3 \]

\[ 15 \div 9 \]

**evaluate**

\[ (14 - 7) \times 5 = ? \]

\[ 7 \times 5 = 35 \]

**expression**

<table>
<thead>
<tr>
<th>Picture</th>
<th>Numbers</th>
<th>Words</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Picture" /></td>
<td>6 + 2</td>
<td>six and two more</td>
</tr>
</tbody>
</table>

**operations**

- addition (+)
- subtraction (−)
- multiplication (×)
- division (÷)

**variable**

\[ y \times 2 = 8 \]
Ideas for Use

- During this school year, create a separate stack of cards for key math verbs, such as evaluate. These verbs will help you in your problem solving.

- Use the blank card to write examples that will help you with concepts like writing and evaluating expressions.

This property allows you to decompose one factor into addends that are easier to multiply.

**How can you use this method to find** \( 7 \times 2 \)?

The property that states that the grouping of factors does not change the product. It can make multiplying 3 numbers easier.

**Write a number sentence that is an example of the Associative Property of Multiplication.**

To find the value of an expression.

**How do parentheses help you evaluate the problem on the front of the card?**

A sentence that contains an equals sign (=), showing that two expressions are equal.

**How does knowing the meaning of equal help you remember the definition of equation?**

A mathematical process, which includes addition, subtraction, multiplication, and division.

**Explain in your own words what it means to multiply.**

A combination of numbers and operations that represent a quantity.

**How can the meaning of the word “express” help you remember what an expression is?**

A letter or symbol, such as \( x \), \( ?, \) or \( m \) used to represent an unknown quantity.

**Variable** is a multiple-meaning word. Use a dictionary to write the meaning of variable used in this sentence. **The weather during spring can be variable.**
Commutative Property of Multiplication

Distributive Property

Associative Property of Multiplication
**Explain**

The property which states the ____________ in which two numbers are multiplied does not change the ____________.

**Example**

\[ \boxed{\text{5} \times \boxed{\text{3}}} = \boxed{\text{15}} \]

**Explain**

The property which allows me to ______________ factors into addends that are easier to work with.

**Example**

\[ 2 \times 4 = (2 \times 3) + (2 \times 1) \]

\[ = \boxed{\text{3}} + \boxed{\text{1}} \]

\[ = \boxed{\text{4}} \]

**Explain**

The property which states that the grouping of ____________ does not change the ____________.

**Example**

\[ (1 \times 2) \times 3 = \boxed{\text{3}} \]

\[ \boxed{1} \times \boxed{\text{3}} = \boxed{\text{3}} \]

\[ 1 \times (2 \times 3) = \boxed{\text{3}} \]

\[ \boxed{1} \times \boxed{\text{3}} = \boxed{\text{3}} \]
Hands On
Take Apart to Multiply

When you take apart, or decompose, a factor, you have smaller numbers that are easier to multiply.

Build It

Find $4 \times 7$.

1. **Model $4 \times 7$.**
   Use color tiles to make a $4 \times 7$ array.
   Draw the array.

2. **Decompose one factor.**
   - Take apart the 7.
   - Separate 7 columns into 5 columns + 2 columns.

3. **Find the products of each part.**
   Then add.

   $4 \times 7 = (4 \times 5) + (4 \times 2)$

   $= \underline{\underline{\underline{\quad + \quad}}}$

   $= 28$

   So, $4 \times 7 = \underline{\underline{\underline{\quad}}}$.
Try It

Gretchen cut 6 oranges into 9 slices each. How many orange slices are there?

Find $6 \times 9$.

1. Outline a $6 \times 9$ array on the grid paper.

2. **Decompose one factor.**
   
   Draw a vertical line through the array to decompose the factor 9 into 5 + 4. Write the addends above.

3. **Find the product of each part.**
   
   Multiply. Then add the products.
   
   \[
   6 \times 9 = (6 \times \underline{5}) + (6 \times \underline{4})
   \]
   
   \[
   = \underline{30} + \underline{24}
   \]
   
   \[
   = \underline{54}
   \]

So, $6 \times 9 = \underline{54}$. There are \underline{54} orange slices.

Talk About It

1. **Mathematical Practice E Justify Conclusions** In the example above, could the 6 have been decomposed instead of the 9? Explain.

2. How is decomposing a factor helpful in finding products?

3. Explain how using a known fact strategy is similar to decomposing a factor.
Practice It

Use color tiles to model the array. Decompose one factor. Then find the product for each part and add.

4. \[7 \times 6 = (7 \times \_\_\_) + (7 \times \_\_\_)\]

5. \[8 \times 7 = (8 \times \_\_\_) + (8 \times \_\_\_)\]

6. Decompose one factor. Color the array two colors to represent your numbers. Then find the product for each part and add.

\[7 \times 9 = (7 \times \_\_\_) + (7 \times \_\_\_)\]

7. Decompose the fact a different way.

\[7 \times 9 = (7 \times \_\_\_) + (7 \times \_\_\_)\]
Apply It

8. Mr. Daniels bought 9 packages of metal brackets to build some bookshelves. There are 8 brackets in each package. How many brackets did Mr. Daniels buy altogether?


10. Eight horses each ate the number of apples shown. How many apples did they eat altogether?

11. Reason How could you change Exercise 8 so that Mr. Daniels buys a total of 81 brackets?

Write About It

12. How does decomposing a factor allow you to group numbers differently?
Lesson 1
Hands On: Take Apart to Multiply

**Homework Helper**

Find $4 \times 9$.

1. **Make an array to model $4 \times 9$.**

2. **Decompose one factor.**
   Take apart the 9 to make 5 and 4.

3. **Find the product for each part.**
   
   
   \[
   4 \times 9 = (4 \times 5) + (4 \times 4) \\
   = 20 + 16 \\
   = 36
   \]

So, $4 \times 9 = 36$.

**Practice**

Decompose one factor. Color the array two colors to represent your numbers. Then find the product for each part and add.

1.  
   \[
   7 \times 7 = (7 \times 5) + (7 \times 4) \\
   = \underline{35} + \underline{28} \\
   = \underline{63}
   \]

2.  
   \[
   6 \times 8 = (6 \times 5) + (6 \times 3) \\
   = \underline{30} + \underline{18} \\
   = \underline{48}
   \]

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Decompose one factor. Find each product. Then add. Decompose the fact a different way below.

3. \( 8 \times 8 = (8 \times \_\_) + (8 \times \_\_) \)
4. \( 5 \times 7 = (5 \times \_\_) + (5 \times \_\_) \)

Another way:
3. \( 8 \times 8 = (8 \times \_\_) + (8 \times \_\_) \)
4. \( 5 \times 7 = (5 \times \_\_) + (5 \times \_\_) \)

**Problem Solving**

Decompose one factor. Find each product. Then add.

**5. Practice** Identify Structure Orlando’s baby sister takes 3 naps a day. How many naps does she take in 9 days?

6. Carli gets to the bus stop 5 minutes early each morning. How many minutes does she wait at the bus stop in 5 days?

7. Every Monday, Wednesday, and Friday, Mr. Brennan walks 2 miles and jogs 4 miles. What is the total number of miles Mr. Brennan walks and jogs in two weeks?
The **Distributive Property** allows you to decompose one factor. Then you can use smaller known facts to find products.

**Math in My World**

**Example 1**

Henry's Hardware Store sells wrench sets. Each set holds 6 wrenches. How many wrenches are there in 8 sets?

Find $8 \times 6$.

Decompose one factor.
One way is to decompose 6 into $5 + 1$.

\[
8 \times 6 = (8 \times 5) + (8 \times 1)
\]

\[
= 40 + 8
\]

So, $8 \times 6 = \underline{48}$. There are \underline{48} wrenches.
Example 2

Karina's dad used 7 boards to build a picnic table. How many nails were used if each board needed 7 nails?

Find $7 \times 7$.

Decompose one factor. One way is to decompose 7 into $5 + 2$.

$$7 \times 7 = (\text{ } \times \text{ } ) + (\text{ } \times \text{ } )$$

Multiply.

$$= \text{ } + \text{ }$$

Add.

So, Karina and her dad used _______ nails altogether.

Guided Practice

Use the Distributive Property to find each product.

1. $8 \times 3 = (\text{ } \times \text{ } ) + (\text{ } \times \text{ } )$

$$= \text{ } + \text{ }$$

2. $8 \times 8 = (\text{ } \times \text{ } ) + (\text{ } \times \text{ } )$

$$= \text{ } + \text{ }$$
Independent Practice

Use the Distributive Property to find each product.

3. \( 4 \times 6 = \) 

4. \( 6 \times 6 = \) 

5. \( 8 \times 9 = \) 

6. \( 10 \times 4 = \) 

7. \( 12 \times 4 = \) 

8. \( 11 \times 8 = \) 

9. \( 10 \times 10 = \) 

10. \( 12 \times 6 = \)
11. Identify Structure The Fix It Right Hardware Store is open 12 hours every day. How many hours are they open altogether from Monday through Friday?

12. A restaurant orders 9 dozen eggs. The picture shows the number of eggs from each dozen that broke during shipping. How many eggs are unbroken? (Hint: 1 dozen = 12)

13. Each aquarium has 10 clown fish and 6 puffer fish. There are 7 aquariums. How many fish are there in all?

HOT Problems

14. Make Sense of Problems There are 12 inches in one foot and 3 feet in one yard. How many inches are in 2 yards?

15. Building on the Essential Question How are parentheses used when grouping factors?
Melanie ran 6 laps around a track each day for 7 days. How many laps did Melanie run that week?

Find $6 \times 7$.

**One Way** Decompose 7 into $5 + 2$.

\[
6 \times 7 = (6 \times 5) + (6 \times 2)
\]
\[
= 30 + 12
\]
\[
= 42
\]

**Another Way** Decompose 7 into $3 + 4$.

\[
6 \times 7 = (6 \times 3) + (6 \times 4)
\]
\[
= 18 + 24
\]
\[
= 42
\]

$6 \times 7 = 42$

So, Melanie ran 42 laps in one week.

**Practice**

Use the Distributive Property to find each product.

1. $4 \times 9 = \underline{36}$
2. $5 \times 6 = \underline{30}$
Use the Distributive Property to find each product.

3. \(5 \times 11 = \) \hspace{1cm} 4. \(12 \times 7 = \)

**Problem Solving**

5. Milly bought 4 bags of apples at the grocery store. Each bag contains 6 apples. How many apples does Milly have in all?

6. **Mathematical PRACTICE Identify Structure** Byron scrambled 8 dozen eggs for the campers. What is the total number of eggs Byron scrambled? (Hint: 1 dozen = 12)

7. There are 6 seats in each row in the theater. If 8 rows are filled with people, how many people are in the theater?

**Vocabulary Check**

8. Explain how you could use the Distributive Property to decompose a factor and find the product of \(5 \times 9\).

**Test Practice**

9. Which shows the correct use of the Distributive Property to find \(4 \times 12\)?

   A. \((2 \times 6) + (2 \times 6)\)  
   B. \((4 \times 10) + (4 \times 2)\)  
   C. \((4 \times 6) + (2 \times 6)\)  
   D. \((4 \times 8) + (4 \times 3)\)
The way you group factors when you multiply does not change the product.

Build It

Find \((2 \times 3) \times 3\).

1. Use counters to model \((2 \times 3) \times 3\).

   2 groups of 3, three times

   Draw and label the models.

   \[
   \begin{array}{ccc}
   & & \\
   & 3 & \\
   & & \\
   \end{array}
   \times
   \begin{array}{ccc}
   & & \\
   & 3 & \\
   & & \\
   \end{array}
   \times
   \begin{array}{ccc}
   & & \\
   & 3 & \\
   & & \\
   \end{array}
   \]

2. Multiply the factors inside the parentheses first.

   \((2 \times 3) \times 3\)

3. Multiply the product by the remaining factor.

   So, \((2 \times 3) \times 3 = \)
Try It

Group the same factors another way.
Find \(2 \times (3 \times 3)\).

1. **Use counters to model** \(2 \times (3 \times 3)\)
   
   Draw and label the models.

2. **Multiply the factors in the parentheses first.**

3. **Multiply the product with the remaining factor.**

So, \(2 \times (3 \times 3) = \) also.

Either way you group the factors, the product is .

Talk About It

1. **Practice**  
   **Stop and Reflect** Compare the models from each activity. How are they similar? How are they different?

2. Were the products different in the two examples? Explain.

3. How is grouping factors helpful when multiplying three or more factors?
Practice It

Find each product.

4. \(3 \times (2 \times 2) = \) 
5. \(1 \times (4 \times 2) = \) 
6. \((5 \times 2) \times 2 = \)

7. \((5 \times 1) \times 3 = \) 
8. \(4 \times (2 \times 3) = \) 
9. \((3 \times 3) \times 3 = \)

10. \((4 \times 3) \times 2 = \) 
11. \((4 \times 1) \times 5 = \) 
12. \((4 \times 2) \times 2 = \)

Group the factors another way. Then find each product.

13. \((3 \times 2) \times 4 = \) \(3 \times (2 \times \) \()\) 
14. \((2 \times 2) \times 4 = \) \(2 \times (\) \()\)

\[= \times \]
\[= \]

15. \(5 \times (2 \times 3) = (\) \times \) \()\) 
16. \((4 \times 2) \times 3 = 4 \times (\) \()\)

\[= \times \]
\[= \]

17. \((3 \times 3) \times 2 = \) \(3 \times (\) \()\) 
18. \((4 \times 3) \times 3 = 4 \times (\) \()\)

\[= \times \]
\[= \]
19. **Use Number Sense** A hardware store carries 3 kinds of bolts. James buys 3 boxes of each kind of bolt. Each box costs $5. How much did James spend at the hardware store?

20. Cody walked his dog 2 times a week for 5 weeks. After every walk, Cody gave his dog 2 treats. How many treats did Cody's dog get after 5 weeks?

21. Each van has 5 rows of seats with room for 3 passengers in each row. There are 2 vans and every row is filled. How many passengers are there altogether?

22. There are 4 rooms in each apartment and there are 3 apartments on each floor. How many rooms are there on 2 floors?

23. **Find the Error** Sam described the multiplication sentence below as four groups of four, two times. Find and correct his mistake.

\[ 4 \times (2 \times 2) \]

**Write About It**

24. Explain the difference between finding the product of \(3 \times (2 \times 2)\) and finding the product of \((3 \times 2) \times 2\).
Lois does 2 loads of laundry 2 times each week. How many loads of laundry does Lois do in 4 weeks?

1. Model $(2 \times 2) \times 4$.
   - 2 groups of 2, four times
   - $2 \times 2$ $2 \times 2$ $2 \times 2$ $2 \times 2$

2. Multiply the factors inside the parentheses first.
   - $(2 \times 2) \times 4$
   - $4 \times 4$
   - 16

3. Multiply the product by the remaining factor.
   - So, $(2 \times 2) \times 4 = 16$. Lois does 16 loads of laundry in 4 weeks.

You can also group the factors another way.

- $2 \times (2 \times 4)$
   - 2 groups of 4, two times
   - $2 \times 4$ $2 \times 4$

Either way you group the factors, the product is 16.

Practice

Find each product.

1. $(3 \times 1) \times 2 = \underline{6}$
2. $(2 \times 2) \times 5 = \underline{20}$
Find each product.

3. \((6 \times 1) \times 3 = \) 4. \(3 \times (5 \times 2) = \)

Group the factors another way. Then find each product.

5. \((4 \times 1) \times 2 = 4 \times (1 \times )\) 6. \((2 \times 6) \times 2 = 2 \times ( \quad \times )\)

\[= 4 \times \]

\[= \]

7. \(3 \times (5 \times 1) = ( \quad \times ) \times 1\) 8. \((4 \times 5) \times 2 = 4 \times ( \quad \times )\)

\[= \]

\[= \]

Problem Solving

9. **Use Number Sense** Caroline baked bread each day for 5 days for a bake sale. She baked 3 types of bread each day and used 2 cups of flour for each recipe. How many cups of flour did Caroline use?

10. Each of the 4 members of the Kings Chess Club play in 3 matches both Saturday and Sunday. How many matches did the chess club play in all?

11. Kent works at an ice cream shop. A family of 3 ordered 3 scoops of ice cream each. Then two more families of 3 ordered 3 scoops of ice cream each. How many scoops of ice cream did Kent serve to the three families in all?
The **Associative Property of Multiplication** states that the grouping of factors does not change the product.

**Math in My World**

**Example 1**

Chris and Katie each received 4 smile stickers a week for 3 weeks. How many smile stickers did they earn altogether?

Find the unknown in \(2 \times 3 \times 4 = \_\) .

When there are no parentheses, multiply in order from left to right. Or, use parentheses to group factors.

**One Way** Multiply 2 and 3 first.

\[(2 \times 3) \times 4 = \_] \]

\[
6 \times 4 = \_]

The unknown is \_ .

**Another Way** Multiply 3 and 4 first.

\[2 \times (3 \times 4) = \_ \]

\[2 \times 12 = \_ \]

The unknown is \_ .

Either way \(2 \times 3 \times 4 = \_ \).

The \_ Property shows that grouping does not change the product.

**Helpful Hint**

The Associative Property also allows you to group the easier factors.
Example 2

Cheryl has 2 photos. Each photo shows 5 friends holding the same number of flowers. There are 30 flowers altogether. How many flowers is each friend holding?

Write a multiplication sentence to help you find the missing factor.

<table>
<thead>
<tr>
<th>number of photos</th>
<th>number of friends</th>
<th>flowers each is holding</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

Use the Associative Property of Multiplication to find $2 \times 5$ first.

$$(2 \times 5) \times \boxed{} = 30$$

$10 \times \boxed{} = 30$

THINK 10 times what number equals 30?

$10 \times \boxed{} = 30$

So, $2 \times 5 \times 3 = \boxed{}$. Each friend is holding $\boxed{}$ flowers.

Guided Practice

Use parentheses to group two factors. Then find each product.

1. $2 \times 4 \times 6 = (\boxed{\phantom{0}} \times \boxed{\phantom{0}}) \times \boxed{\phantom{0}}$
2. $4 \times 2 \times 3 = \boxed{\phantom{0}} \times (\boxed{\phantom{0}} \times \boxed{\phantom{0}})$

$\boxed{\phantom{0}} \times \boxed{\phantom{0}} = \boxed{\phantom{0}}$

$\boxed{\phantom{0}} \times \boxed{\phantom{0}} = \boxed{\phantom{0}}$

3. Algebra Find the missing factor.

$\boxed{\phantom{0}} \times (2 \times 3) = 30$

$\boxed{\phantom{0}} \times \boxed{\phantom{0}} = \boxed{\phantom{0}}$

$\boxed{\phantom{0}} \times \boxed{\phantom{0}} = \boxed{\phantom{0}}$

So, the unknown is $\boxed{\phantom{0}}$. 

Talk MATH

Explain how the Associative Property of Multiplication can help you find missing factors.
Independent Practice

Use parentheses to group two factors. Then find each product.

4. $4 \times 1 \times 3 = ( \quad \times ) \times$
   $= \quad \times$

5. $2 \times 3 \times 3 = \times ( \quad \times )$
   $= \quad \times$

6. $6 \times 2 \times 2 =$

7. $2 \times 3 \times 2 =$

Algebra Find each missing factor.

8. $(3 \times \text{□}) \times 4 = 24$
   The unknown is ___.

9. $(6 \times \text{□}) \times 5 = 30$
   The unknown is ___.

10. $\text{□} \times (3 \times 3) = 27$
    The unknown is ___.

11. $(2 \times 5) \times \text{□} = 20$
    The unknown is ___.

Algebra Find the value of each number sentence.

12. $(6 \times 1) \times \text{□} =$

13. $4 \times (\text{□} \times 2) =$

14. $\text{□} \times (\text{□} \times 5) =$

15. $(6 \times \text{□}) \times 3 =$

16. $\text{□} \times (3 \times \text{□}) =$

17. $(5 \times \text{□}) \times \text{□} =$

Key

- $\text{□} = 2$
- $\text{□} = 3$
- $\text{□} = 4$
18. **Make a Plan**  There are 5 apples. Troy cuts each apple into 2 pieces. Beth cuts each piece into 4 slices. What is the total number of apple slices?

19. Troy and Beth each cut 2 bananas into 4 pieces. What is the total number of banana pieces?

20. A clerk unpacked 2 boxes of nails. Each box held 4 cartons with 10 packages of nails. How many packages of nails did the clerk unpack?

### HOT Problems

21. **Find the Error** From the following, circle the number sentence that is not true. Explain.

\[
(2 \times 3) \times 3 = 2 \times (3 \times 3)
\]

\[
3 \times (1 \times 5) = (3 \times 1) \times 5
\]

\[
4 \times (4 \times 2) = (3 \times 4) \times 4
\]

\[
6 \times (4 \times 2) = (6 \times 4) \times 2
\]

22. **Building on the Essential Question** Explain why the grouping of the factors does not matter when finding \((3 \times 4) \times 2\).
Taylor and his friend bought 2 small pizzas. They cut each pizza into 4 pieces. Taylor put 5 black olives on each piece of pizza. How many black olives did Taylor use in all?

Find $2 \times 4 \times 5$. Use parentheses to group the factors.

**One Way** Multiply 2 and 4 first.

$$\begin{align*}
(2 \times 4) \times 5 &= 8 \times 5 \\
&= 40
\end{align*}$$

**Another Way** Multiply 4 and 5 first.

$$\begin{align*}
2 \times (4 \times 5) &= 2 \times 20 \\
&= 40
\end{align*}$$

Taylor used 40 black olives in all.

Either way you group the factors, the product is 40.

The Associative Property states that the way factors are grouped does not change the product.

**Practice**

Use parentheses to group two factors. Then find each product.

1. $2 \times 3 \times 6 =$
2. $5 \times 2 \times 2 =$
Algebra  Find each missing factor.

3.  $4 \times (\_ \times 4) = 32$

   The unknown is $\_$.

4.  $(2 \times \_ \times 6 = 60$

   The unknown is $\_$.

5.  $(5 \times \_ \times 1 = 45$

   The unknown is $\_$.

6.  $\_ \times (4 \times 2) = 48$

   The unknown is $\_$.

Problem Solving

7.  **Use Number Sense** Mariette bought 4 packs of sparkling water. There were 6 bottles in each pack. If each bottle cost $2, how much did Mariette spend on sparkling water?

8.  Jamal and Brianna each bought 3 oranges. They sliced each orange into 6 pieces. How many orange slices did Jamal and Brianna have altogether?

9.  Mr. and Mrs. Perry packed their lunch 5 days in a row. Each of them packed 3 oatmeal cookies for dessert every day. What is the total number of cookies they packed for lunch that week?

Vocabulary Check

10. Write a definition for the Associative Property of Multiplication.

Test Practice

11. What is the unknown in $(3 \times 3) \times 7 = \_ $

   A  21  
   B  30  
   C  42  
   D  63

524  Need more practice? Download Extra Practice at connectED.mcgraw-hill.com
Choose the correct word(s) to complete each sentence.

**Associative Property of Multiplication**

**decompose**

1. \[ 5 + 2 \]
   \[
   \begin{array}{ccc}
   4 & & \\
   & 4 & \\
   & & 8
   \end{array}
   \]

One way to find \( 4 \times 7 \) with models is to decompose the factor 7 into addends of 5 + 2.

**Distributive Property**

**parentheses**

2. \[ 6 \]
   \[
   \begin{array}{ccc}
   3 & & \\
   & 3 & \\
   & & 8
   \end{array}
   \]

   \[
   \begin{array}{ccc}
   8 & & \\
   & 5 & \\
   & & 8
   \end{array}
   \]

   \[ 8 \times 5 = (8 \times 3) + (8 \times 3) \]

The **decompose** allows you to decompose one factor into addends that are easier to multiply. Then you can use smaller known facts to find products.

3. \[ (2 \times 3) \times 4 = 24 \]
   \[ 2 \times (3 \times 4) = 24 \]

The **associative** states that the grouping of the factors does not change the product.

4. \[ (2 \times 3) \times 4 \]
   \[
   \begin{array}{ccc}
   6 & & \\
   & 4 & \\
   & & 24
   \end{array}
   \]

The **associative** show the grouping of the factors to multiply first.
Concept Check

Use the Distributive Property to find each product.

5. \(9 \times 6 = ( \underline{\hspace{1cm}} \times \underline{\hspace{1cm}} ) + ( \underline{\hspace{1cm}} \times \underline{\hspace{1cm}} )\)

\[= \hspace{1cm} + \hspace{1cm} = \]

Find each product.

7. \(3 \times (4 \times 2) = \)
8. \(2 \times (3 \times 2) = \)
9. \((5 \times 2) \times 1 = \)

10. \((2 \times 3) \times 3 = \)
11. \(4 \times (2 \times 3) = \)
12. \((3 \times 3) \times 2 = \)

Algebra Find each missing factor.

13. \((4 \times \underline{\hspace{1cm}}) \times 3 = 24\)
14. \((3 \times \underline{\hspace{1cm}}) \times 3 = 27\)

\[\underline{\hspace{1cm}} = \hspace{1cm} \underline{\hspace{1cm}} = \]

Problem Solving

15. Amanda wrote 3 stories in Writer’s Workshop. Each story was 6 pages long. She drew 2 illustrations on each page. How many illustrations did Amanda draw altogether?

16. Mrs. Andrew’s classroom has 4 rows of desks with 3 desks in each row. She placed 2 pencils on each desk. How many pencils did Mrs. Andrew place on the desks altogether?

Test Practice

17. Becka made 2 cards. She drew 3 balloons on each card. Each balloon had 3 stars. How many stars did Becka use on her cards altogether?

A 15 stars  C 17 stars
B 16 stars  D 18 stars
Write Expressions

The four operations are addition, subtraction, multiplication, and division. An expression is a number or a combination of numbers and operations. An expression does not have an equals sign.

Math in My World

Example 1
Alice invited three friends to play in her backyard. Write an expression to represent the total number of friends.

Use pictures.  

\[ \text{Alice} \rightarrow \text{three friends} \]

Use numbers.  

\[ 1 + \underline{} \]

Use words.  

\[ \underline{} \text{ plus three, or } \underline{} \text{ more than one} \]

Example 2
Five nails were hammered in the wood. One nail bent. Write an expression to represent the number of good nails left.

Use pictures.  

\[ \text{Five nails were hammered.} \]

Use numbers.  

\[ 5 - \underline{} \]

Use words.  

\[ \underline{} \text{ five minus } \underline{} , \text{ or } \underline{} \text{ less than five} \]
Example 3
Tracy bought 3 magnets. Scott has two times as many. Then Tracy buys one more. Write an expression to represent the total number of magnets.

Use pictures.

Use numbers. \((\underline{3} \times 2) + 1\)

Use words. two three plus ,
or, groups of three plus one more

Guided Practice
Model each expression with pictures, numbers, and words.

1. Jeff had 8 crayons. He lost 5 of them.

<table>
<thead>
<tr>
<th>Picture</th>
<th>Numbers</th>
<th>Words</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. A carpenter has six nails. She went to the store to buy three more. She used 2 nails.

<table>
<thead>
<tr>
<th>Picture</th>
<th>Numbers</th>
<th>Words</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(6 + 3)</td>
<td>six plus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>minus</td>
</tr>
</tbody>
</table>
Independent Practice

Use numbers and operations to write each phrase as an expression.

3. 4 more than 7                                      4. the total of 5 rows of 6 chairs

5. half of 18                                          6. 3 people equally divide $21

7. difference between 89 and 80                       8. 6 groups with 6 people in each

There are 6 nails in the toolbox. Write an expression to
tell how many there will be when there are:

9. 2 fewer nails                                      10. 4 times as many nails

11. half as many nails                                 12. 10 more nails

13. 3 equal groups of nails

Write an expression for each.

14. the cost of 5 bottles of glue

15. the number of nails for 90¢

16. the total cost of a spool of wire, tape measure, and a bottle of glue
Problem Solving

Mathematical PRACTICE Model Math Write an expression for each situation.

17. There were 6 groups of scouts. Each group earned 9 Build-It badges.

18. Mr. Lewis bought a flat of flowers for $22. How much change should he receive if he paid with two $20 bills?

\[(\$20 + \$20)\]

19. Each package of tape is 9 feet long. When Taryn buys 2 rolls, how many yards of tape will she have? (Hint: 1 yard = 3 feet)

\[(2 \times 9)\]

HOT Problems

Mathematical PRACTICE Which One Doesn’t Belong? Circle the phrase that does not belong. Explain.

\[\text{$25$ more than $30$} \quad \text{16 more than 17} \quad \text{12 less than 15} \quad \text{12 plus 14 equals 26}\]

21. Building on the Essential Question What kinds of specific words or phrases can be used to represent each of the four operations?
Charles filled 4 balloons for the party. Model each of the following situations with pictures, numbers, and words.

Charles filled 2 more balloons.

Numbers: $4 + 2$
Words: four plus two

Charles filled twice as many balloons.

Numbers: $4 \times 2$
Words: four times two

One balloon floats away.

Numbers: $4 - 1$
Words: one less than four

Charles gives half of the balloons to Lia.

Numbers: $4 \div 2$
Words: half of four

Practice

1. Annette has 6 pencils. She divides them evenly among 3 friends. Model the expression with a picture, numbers, and words.

<table>
<thead>
<tr>
<th>Picture</th>
<th>Numbers</th>
<th>Words</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Use numbers and operations to write each phrase as an expression.

2. 4 boxes with 2 shoes in each  
3. the difference between 58 and 47

4. 5 more than 12  
5. 30 books shared equally by 10 people

Problem Solving

Model Math Write an expression for each situation.

6. Stella read all but one of the 5 books she took on vacation.

7. Ms. Benson had a box of 8 popsicles. She bought another box of 4 popsicles. Ms. Benson divided the popsicles among her 2 children.

\[(12) \div 2\]

8. Frieda bought 3 packs of 8 candles. Then she found 1 candle at home.

\[(3 \times 8)\]

Vocabulary Check

Match each vocabulary word with its example.

9. expression  
   - \(7 \times 4\)
10. operations  
    - \(+, -, \times, \text{ and } \div\)

Test Practice

11. Zoe had 9 bracelets. She lost 1 and gave 3 to Blaire. Which expression matches the situation?

   \(\text{(A) } 9 - 3\)  
   \(\text{(B) } (9 - 1) + (9 - 3)\)  
   \(\text{(C) } 9 - 1 - 3\)  
   \(\text{(D) } (9 - 1) + 3\)
Evaluate Expressions

When a symbol, such as ? and □, or a letter, such as x or y, is used to stand for an unknown, it is called a variable.

Math in My World

Example 1

Santiago unpacked 5 more boxes of light bulbs than boxes of flashlights.

Write an expression using the variable x for the unknown.

expression

$5 + x$  Say: five plus x  variable

When you find the value of an expression by replacing the variable with a number, you evaluate the expression.

Example 2

The hardware store has 6 fewer step ladders than extension ladders. There are y extension ladders. Write an expression using the variable y. Then evaluate the expression if $y = 10$.

$y - 6$  Write the expression.

$10 - 6$  Replace y with 10.

Subtract.

There are step ladders.
Sometimes an expression has more than one operation. When there are no parentheses, multiply and/or divide in order from left to right. Then add and/or subtract in order from left to right.

**Example 3**

Owen looked at a set of 4 pliers. His dad looked at a set that had $s$ times as many pliers plus 3 more. If $s = 2$, how many pliers were in the set Owen’s dad looked at?

Write an expression, then evaluate it.

1. Write the expression.
   
   $3 + s \times 4$

2. Replace $s$ with 2.
   
   $3 + 2 \times 4$

3. When there are no parentheses, first multiply or divide, in order from left to right.
   
   $3 + 8$

4. Then, add or subtract, in order from left to right.
   
   $11$

So, if $s = 2$, then $3 + s \times 4 = 11$. There were __________ pliers in the set.

**Guided Practice**

Evaluate each expression if $a = 2$ and $b = 5$.

1. $3 + a$
   
   $3 + 2 = 5$

2. $11 - b$
   
   $11 - 5 = 6$

3. $b \times 4$
   
   $5 \times 4 = 20$

4. $12 \div a + 4$
   
   $12 \div 2 + 4 = 8$

---

Look back at Example 3. How would your answer be different if you evaluated the expression left to right? Explain.
Independent Practice

Algebra Evaluate each expression if \( z = 7 \) and \( y = 20 \).

5. \((8 \times z) - y\)  
6. \(y + 3 \times 4\)  
7. \(y \div 5\)

8. \(6 \times 4 - y\)  
9. \(z - 5 + 7\)  
10. \(28 \div z \times 6\)

Algebra Draw a line to match the expression to its value if \( g = 2 \).

11. \((5 + 3) \times g\)  
12. \(g \times 5 - 5\)  
13. \(15 - 9 - g\)  
14. \(5 + (3 \times g)\)  
15. \(g \times (5 - 5)\)

* 5  
* 11  
* 0  
* 16  
* 4

Algebra Circle yes or no to tell whether the expression is evaluated correctly if \( n = 12 \).

16. \(n \div 4 \times 6\)  
17. \(12 + n \div 4\)

\[
\begin{align*}
12 \div 4 \times 6 & = 18 \\
3 \times 6 & = 18 \\
12 + 12 \div 4 & = 6 \\
24 \div 4 & = 6 \\
Yes & \quad No \\
Yes & \quad No
\end{align*}
\]

18. Did you circle no for either Exercise 16 or 17? Explain.
Problem Solving

**Mathematical Practice** Use Algebra Write an expression for each. Then evaluate it.

19. Tomas has $10. Aisha has $x$ more than Tomas. If $x = 5$, how much money does Aisha have?

20. There are 5 swing sets at a playground. Each swing set has $v$ swings. If $v = 3$, what is the total number of swings?

21. Jimena put 5 pencils and $n$ pens in a pencil box for each of her 2 friends. If $n = 3$, how many pencils and pens did Jimena put in pencil boxes?

\[(5 + n)\]

HOT Problems

**Mathematical Practice** Identify Structure Neil forgot to place the parentheses on the expression below. Place the parentheses so that the expression has a value of 2.

\[12 - 4 + 6\]

Why are the parentheses important in this expression?

23. Building on the Essential Question When evaluating an expression with more than one operation and no parentheses, how should you proceed?
**Homework Helper**

Kevin used half of the tools from his toolbox. An hour later he put 3 tools back. How many tools is Kevin still using if he had \( z \) tools in his toolbox? Write an expression. Then evaluate the expression if \( z = 8 \).

Write the expression. \( z ÷ 2 - 3 \)

Replace \( z \) with 8. \( 8 ÷ 2 - 3 \)

When there are no parentheses, first multiply or divide, in order, from left to right. \( 8 ÷ 2 = 4 \)

\( 4 - 3 = 1 \)

Kevin is still using 1 tool.

**Practice**

**Algebra** Evaluate each expression if \( c = 4 \) and \( d = 7 \).

1. \( 15 - d \)  
   \( 15 - \quad = \quad \)

2. \( 16 + c \)  
   \( 16 + \quad = \quad \)

3. \( 35 ÷ d \)  
   \( 35 ÷ \quad = \quad \)

**Algebra** Evaluate each expression if \( x = 14 \) and \( y = 6 \).

4. \( (x + y) ÷ 4 \)  
   \( (14 + 6) ÷ 4 = \quad \)

5. \( x - 2 \times 2 \)  
   \( 14 - 2 \times 2 = \quad \)

6. \( y + 24 ÷ 2 \)  
   \( 6 + 24 ÷ 2 = \quad \)
Problem Solving

Model Math Write an expression for each situation. Then evaluate it.

7. Monica has 7 hats. Andrea has $b$ fewer hats than Monica. If $b = 5$, how many hats does Andrea have?

8. There are 4 shelves with canned dog food. Each shelf has $t$ cans. Then Tracy adds 2 cans to only 1 of the shelves. If $t = 8$, how many cans are on the shelves altogether?

   $4 \times t$; $4 \times$

9. Valerie is making identical quilts for herself and her sister. For each quilt she buys 5 yards of solid fabric and $w$ yards of printed fabric. If $w = 4$, how much fabric did Valerie buy to make both quilts?

   $(\quad \quad \quad) \times 2$;

Vocabulary Check

10. Explain what a variable is.

11. What does it mean to evaluate an expression?

Test Practice

12. Evaluate the expression $h + 8 \div 4$ if $h = 16$.

   A 20  C 8  
   B 18  D 6
An **equation**, or number sentence, shows that two expressions are equal. An equation contains an equals sign (=).

### Math in My World

#### Example 1

Use the information shown to find the total number of red and green apples. Write an equation to represent the counters.

- Red apples + Green apples = Total apples

**Equation:** _______ + _______ = _______

The equation _______ + 4 = _______ tells us there are red and green apples.

In order to write an equation, you need to decide what operation to use. There are words and phrases that can suggest whether to add, subtract, multiply, or divide. Here are some examples.

<table>
<thead>
<tr>
<th>Addition</th>
<th>Subtraction</th>
<th>Multiplication</th>
<th>Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>sum</td>
<td>difference</td>
<td>product</td>
<td>quotient</td>
</tr>
<tr>
<td>more</td>
<td>less than</td>
<td>times as many</td>
<td>divide</td>
</tr>
<tr>
<td>in all</td>
<td>left</td>
<td>twice</td>
<td>half</td>
</tr>
<tr>
<td>total</td>
<td>fewer than</td>
<td>in each</td>
<td>into equal groups</td>
</tr>
</tbody>
</table>
Example 2
Hayden used his tape measure to find the total length of a board needed to finish his tree fort. When he cuts the board, one piece will be 48 inches and the other will be 32 inches. What is the total length of the board?

Write an equation to represent the problem.
Use the letter $b$ for the unknown.
The word total suggests adding.

$$48 + 32 = b$$

Example 3
A hardware store ordered 2 sets of monkey wrenches. There are 3 wrenches in each set. After the wrenches are shipped, the store will have a total of 7 wrenches. How many wrenches did they already have?

Write an equation to represent the problem. Use the letter $w$ for the unknown.
The phrases sets and in each set suggest multiplying. The word total suggests adding.

$$2 \times 3 + w = 7$$

Guided Practice

Write an equation to represent each sentence.

1. The total of 3 letters plus 2 letters is $x$ letters.

$$\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_$$

2. A group of 6 has $x$ taken away and 2 are left.

$$\_\_\_\_\_\_\_\_ - \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_$$
Independent Practice

Underline the part of the phrase that suggests which operation to use. Circle the operation.

3. the difference between a pack of flashcards and a pack of pens
   addition  subtraction  multiplication  division

4. the total cost of glue, markers, and pencils
   addition  subtraction  multiplication  division

5. the number of crayons equally separated into each box
   addition  subtraction  multiplication  division

Algebra Write an equation to represent each sentence.

6. 9 inches less than 14 inches is y inches.

7. 24 hammers are divided into y equal sets of 3.

8. 12 fish minus y fish plus 4 more equals 9 fish.

9. 5 games plus two times as many is y games.

Algebra Use the numbers in the table for Exercises 10–12 to write an equation for each sentence.

10. The difference between the number of nails and hooks is m hooks.

11. The number of hooks, springs, and bolts altogether is t tools.

12. Half the number of hooks plus the number of nails is n tools.
Problem Solving

Mathematical Practice Use Algebra Write an equation using any letter for the unknown.

13. Steph used some nails from the toolbox. Her dad used 9 nails. How many nails did Steph use if they used 17 nails altogether?

14. Twenty customers ordered sandwiches. Three ordered a ham sandwich. Thirteen ordered a chicken sandwich. The rest ordered a turkey sandwich. How many customers ordered a turkey sandwich?

15. Al gave his iguana 12 beans. The iguana ate half of them by noon. How many beans were left at the end of the day if the iguana ate 4 more?

HOT Problems

Mathematical Practice Model Math Write a real-world problem that can be solved using the equation 16 \div 2 - 3 = n.

16. Building on the Essential Question How are letters and symbols used in equations?
Homework Helper

Use the numbers in the table to write an equation for each situation. Use x for the unknown.

<table>
<thead>
<tr>
<th>Sammy's Pets</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>12</td>
</tr>
<tr>
<td>Hamsters</td>
<td>4</td>
</tr>
<tr>
<td>Dogs</td>
<td>2</td>
</tr>
<tr>
<td>Birds</td>
<td>3</td>
</tr>
</tbody>
</table>

The difference between the number of fish and the number of birds is x.

\[ 12 - 3 = x \]

The total number of pets is x.

\[ 12 + 4 + 2 + 3 = x \]

Two times the number of hamsters minus x equals the number of dogs.

\[ 2 \times 4 - x = 2 \]

The number of fish grouped equally into three aquariums is x.

\[ 12 \div 3 = x \]

Practice

Algebra Write an equation to represent each sentence.

1. Five more than 7 shells is s.

2. Four times as many as 4 pencils is p.

3. Half as many as 18 squirrels is x.

4. Eleven spoons minus s equals 9 spoons.
**Algebra** Write an equation to represent each sentence.

5. 3 more than 14 eggs divided into 2 equal groups is $e$.

6. 5 boxes of muffins with $m$ number in each box equals 30.

7. The total of 13 cherries, 8 more cherries, and 2 more cherries is $c$.

8. 32 tennis balls shared equally by 4 players plus 3 more is $b$.

**Problem Solving**

**Mathematical Practice**

Use Algebra Write an equation using any letter for the unknown.

9. Irving paid for his lunch with a $10 bill and got $6 back in change. How much did his lunch cost?

10. Erin's beagle weighs 35 pounds. Her Great Dane weighs twice as much as the beagle plus 2 more pounds. How much does the Great Dane weigh?

**Vocabulary Check**

11. Explain the difference between an expression and an equation.

**Test Practice**

12. Venus bought 3 loaves of bread that have 20 slices each. Then she used 2 slices to make a sandwich. There are $b$ slices left. Which equation represents the situation?

   - A $3 \times 20 - 2 = b$
   - B $3 + 20 - 2 = b$
   - C $(3 \times 20) \div 2 = b$
   - D $3 + 20 - b = 2$
Sometimes in order to solve a problem you need to do more than one step or use more than one operation.

**Math in My World**

**Example 1**

**Gustavo bought some tools at the hardware store. He bought five tools for $6 each and one tool for $7. How much did he spend altogether on tools?**

Write an equation with a letter for the unknown. Then solve.

$$\text{tools bought} \times \text{cost of each tool} + \text{cost of one more tool} = \text{unknown}$$

$$5 \times 6 + 7 = y$$

$$\text{So, } 5 \times 6 + 7 = $ \text{. The unknown is }$.$$}

Gustavo spent $ on tools.

**Check** Use mental math to check your answer for reasonableness.

Gustavo had $37 and spent $7. $37 - 7 = $

Since $30 \div 5 \text{ tools } = $ each, the answer is reasonable.
Example 2

Orlon has 48 comic books. He keeps 8 for himself and divides the rest equally among his friends. If each friend gets 8 comic books, to how many friends did he give comic books?

Write an equation with a letter for the unknown. Then solve.

\[
\begin{array}{c|c|c|c}
\text{comic books} & \text{comic books} & \text{friends} & \text{comic books} \\
\text{Orlon has} & \text{he is keeping} & \text{each gets} & \\
\hline
48 & - & 8 & \div \quad m & = \quad 8 \\
\hline
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{So,} \quad (48 - 8) & \div & \quad m & = \quad 8 \\
\text{The unknown is} & \text{The unknown is} & \text{8} & \text{8} \\
\end{array}
\]

Orlon gave \( \frac{m}{8} \) of his friends comic books.

Check Use estimation to check your answer for reasonableness.

\[
\begin{align*}
48 - 8 &= 40 \\
50 - 10 &= 40 \\
40 \div 8 &= 5 \\
40 \div 10 &= 4
\end{align*}
\]

Round 48 to 50. \hspace{1cm} Round 8 to 10.

The estimate 4 is close to the actual number of 5. The answer is reasonable.

Guided Practice

Write an equation with a letter for the unknown. Then solve. Check for reasonableness.

1. A city bus had 14 passengers. At a stop, 5 people got off and 8 people got on. How many people are on the bus now?

2. Grandmother picked 4 times as many apples as pears. What is the difference in the number of apples and pears picked if she picked 8 pears?
Independent Practice

Algebra Write an equation with a letter for the unknown. Then solve. Check for reasonableness.

3. Whitney went to the hobby store. She bought 3 model airplanes for $4 each. She received $8 in change. How much money did she start with?

4. Mr. Robbins gave 9 students one pencil each. That afternoon, he gave 5 more students one pencil each. Now he has 15 pencils. How many pencils did he start with?

5. Look at the table. How many more pens does Carmen have than Pamela and Cesar have together?

<table>
<thead>
<tr>
<th>Name</th>
<th>Pens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pamela</td>
<td>7</td>
</tr>
<tr>
<td>Cesar</td>
<td>9</td>
</tr>
<tr>
<td>Carmen</td>
<td>20</td>
</tr>
</tbody>
</table>

Algebra Circle the correct equation. Then solve the problem.

6. Molly earns $10 each week for babysitting. She spends $3 of that each week and saves the rest. How much money does she save after 8 weeks?

\[ (10 - 3) \times 8 = m \quad 10 - 3 \times 8 = m \]

7. The first 5 pages of Angel's photo album are filled with 8 photos each. The next page has only 7 photos. How many photos are on the 6 pages?

\[ 5 \times 8 + 7 = p \quad 5 \times 8 + p = 40 \]

Algebra Find each unknown.

8. \[ k - 9 = 9 \]
\[ k = \]

9. \[ 45 \div v = 5 \]
\[ v = \]

10. \[ 9 + 2 = 12 - q \]
\[ q = \]
Problem Solving

Mathematical PRACTICE  ➙ Check for Reasonableness Write an equation with a letter for the unknown. Then solve. Check for reasonableness.

11. It rained 6 inches each month for the last 6 months. How much will it need to rain this month for the total rainfall to be 43 inches?

12. There were 48 oranges in 6 equal layers in a box. Mother took some oranges from the top layer for snacks. How many oranges did mother take if there are 5 oranges left on the top layer?

HOT Problems

Mathematical PRACTICE  ➙ Make Sense of Problems Amelia made 10 fruit kabobs. She divided 20 cherries equally among half of the kabobs. How many cherries did each kabob get?

Mathematical PRACTICE  ➙ Find the Error Look back at Exercise 6. Explain why the other choice is incorrect.

Building on the Essential Question Why is it important to perform the operations in an equation in a certain order?
Talia picked 8 quarts of strawberries. She picked half as many quarts of blueberries, then bought 1 more quart of blueberries. How many quarts of blueberries does Talia have?

Write an equation with a letter for the unknown. Then solve.

\[
\begin{align*}
\text{strawberries picked} & \quad \text{blueberries picked} & \quad \text{blueberries bought} \\
8 & \quad \div & \quad 2 & + & \quad 1 & = q \quad \text{unknown} \\
& & 4 & + & 1 & = 5 \\
\end{align*}
\]

So, \(8 \div 2 + 1 = 5\). The unknown is 5. Talia has 5 quarts of blueberries.

**Check** Use mental math to check your answer for reasonableness.

Subtract the one quart Talia bought from the total.
\(5 - 1 = 4\) and 4 is half of 8.

The numbers make sense for the problem. The answer is reasonable.

**Practice**

**Algebra** Find each unknown.

1. \(48 \div 6 + m = 11\)
   
   \[m = \quad \]

2. \(37 - 9 = h \times 4\)
   
   \[h = \quad \]

3. \(20 + 20 = 4 \times w\)
   
   \[w = \quad \]

4. \((4 + 2) \times r = 54\)
   
   \[r = \quad \]
Problem Solving

Check for Reasonableness. Write an equation with a letter for the unknown. Then solve. Check for reasonableness.

5. The football team had its photo taken. There are 3 rows of 8 players each. The fourth row has 6 players. How many players are in the team photo?

6. Mrs. Dove made 15 pancakes. She divided them evenly among Kurt, Joan, and David. Kurt and Joan ate all of their pancakes, but David did not eat some of his. There were 2 pancakes left on David’s plate. How many pancakes did he eat?

7. Keira has 83 spelling words to study in 8 weeks. She already knows 3 words. She will study the same number of words each week. How many spelling words will Keira study each week?

8. Grant bought 6 packs of stickers for $2 each. How much change will Grant receive if he pays with three $5 bills?

Test Practice

9. Isaac has taken five quizzes. He scored 8 points on each of the first 4 quizzes. He scored $y$ points on the fifth quiz. He has scored a total of 41 points. Which equation represents the situation?

- A $41 \div 5 = y$
- B $8 \times 4 \div 5 = y$
- C $4 \times 8 + y = 41$
- D $41 \div 4 + y = 8$
Learn the Strategy

Sara, Barb, and Erin each wrote a different expression. The expressions were $3 + 5 \times 2$, $(3 + 5) \times 2$, and $3 \times 5 + 2$. The value of Barb’s expression is 13. The value of Erin’s expression is an even number. Which expression did each person write?

1 Understand
What facts do you know?
The value of Barb’s expression is ________.
The value of Erin’s expression is an ________ number.

What do you need to find?
which expression each person wrote

2 Plan
I will use logical reasoning to solve the problem.

3 Solve
Find the value of each expression.
$3 + 5 \times 2 = \text{Barb}$
$(3 + 5) \times 2 = \text{}$
$3 \times 5 + 2 = \text{}$

<table>
<thead>
<tr>
<th></th>
<th>Sara</th>
<th>Barb</th>
<th>Erin</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3 + 5 \times 2$</td>
<td>X</td>
<td>yes</td>
<td>X</td>
</tr>
<tr>
<td>$(3 + 5) \times 2$</td>
<td>X</td>
<td>X</td>
<td>yes</td>
</tr>
<tr>
<td>$3 \times 5 + 2$</td>
<td>yes</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

4 Check
Does your answer make sense? Explain.
Practice the Strategy

Caleb, Thi, Joyce, and Lawanda each have one of four pets. Thi does not have a dog or a fish. Joyce does not have a bird or a fish. Caleb has a cat. What pet does each person have?

1. Understand
   What facts do you know?
   
   What do you need to find?

2. Plan

3. Solve

4. Check
   Does your answer make sense? Explain.
Apply the Strategy

Solve each problem by using logical reasoning.

1. Marilee places her language book next to her science book. Her math book is next to her reading book, which is next to her language book. What is one possible order?

2. **Reason** Three friends will put their money together to buy a game that costs $5. Dexter has 5 quarters and 6 dimes. Belle has 6 quarters and 8 dimes. Emmett has 5 coins. If they have 10¢ left over, what coins does Emmett have?

3. Rod is less than 17 years old. The sum of the two digits in his age is even and greater than 4, but both digits are odd. How old is Rod?

4. Jan is 3 inches taller than Dan. Ellie is 2 inches taller than Jan. If Ellie is 54 inches tall, how tall are Jan and Dan?
5. **Plan a Solution** Hailey planted 30 tomato seeds. Three out of every 5 seeds grew into tomato plants. How many tomato plants does Hailey have?

6. There are 11 scouts in a troop. Their van has 4 rows of seats, and each row holds 3 scouts. How many scouts can the van hold?

7. **Use Number Sense** The amusement park sold ride tickets in packs of 5, 10, 15, and 20 tickets. What would a packet of 5 tickets cost if 20 tickets cost $4?

8. Morgan buys 8 packages of 5 bookmarks. Each package costs $2. How much did she spend on the bookmarks?

9. **Make a Plan** Madison can make two apple pies with the apples shown. If she has 9 times as many apples, how many pies can she make?
Homework Helper

Sarah, Parker, Kelly, and Nate each have favorite outfits. Nate wears shorts or pants. Parker always wears something green. Sarah wears shorts, but does not like the color blue. Kelly never wears shorts. Which clothing item could belong to each person?

1 Understand
What facts do you know?
1 know the clothes and colors each person would wear.

What do you need to find?
I need to find which clothing item belongs to each person.

2 Plan
I will use logical reasoning to solve the problem.

3 Solve

<table>
<thead>
<tr>
<th></th>
<th>Red Shorts</th>
<th>Blue Shorts</th>
<th>Green Pants</th>
<th>Brown Pants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarah</td>
<td>yes</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Parker</td>
<td>X</td>
<td>X</td>
<td>yes</td>
<td>X</td>
</tr>
<tr>
<td>Kelly</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>yes</td>
</tr>
<tr>
<td>Nate</td>
<td>X</td>
<td>yes</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

The red shorts could belong to Sarah, the blue shorts to Nate, the green pants to Parker, and the brown pants to Kelly.

4 Check
Does your answer make sense? Yes. The clues match the answer.
Problem Solving

Reason Solve each problem using logical reasoning.

1. Granola bars cost 45¢, gum costs 35¢, and crackers cost 50¢. Lauren buys two different items. She pays with a $1 bill and receives 3 of the same type of coin as change. What did Lauren buy, and what did she receive as change?

2. There are four cars parked next to each other. The blue car is not in the fourth space. The silver car is in the third space. The black car is two spaces in front of the red car. In what order are the cars parked?

3. There are 21 wheels at the bike shop. The wheels will be used to build tricycles and bicycles. There will be half as many tricycles as bicycles. How many of each type of bike will be built?

4. Mitchell has $18 to spend. What is the greatest number of any one item he can buy?

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>cap</td>
<td>$9</td>
</tr>
<tr>
<td>baseball</td>
<td>$10</td>
</tr>
<tr>
<td>stopwatch</td>
<td>$9</td>
</tr>
<tr>
<td>yo-yo</td>
<td>$6</td>
</tr>
<tr>
<td>water bottle</td>
<td>$3</td>
</tr>
</tbody>
</table>
### Vocabulary Check

Use the word bank below to complete each clue.

<table>
<thead>
<tr>
<th>Associative expression</th>
<th>Distributive operations</th>
<th>equation</th>
<th>variable</th>
<th>evaluate</th>
</tr>
</thead>
</table>

#### ACROSS

1. A number sentence that uses the equals sign.

3. The property which allows you to decompose a factor into smaller numbers.

5. A symbol or letter that stands for the unknown.

6. Addition, subtraction, multiplication, and division.

#### DOWN

1. A number or a combination of numbers and operations.

2. The property which states that the grouping of factors does not change the product.

4. To find the value of an expression.
Concept Check

Use the Distributive Property to find each product.

7. $9 \times 7 =$

8. $7 \times 6 =$

Use parentheses to group two factors. Then find each product.

9. $1 \times 3 \times 4 =$

10. $2 \times 5 \times 3 =$

Use numbers and operations to write each phrase as an expression.

11. 5 people equally divide $45$

12. 6 tables with 4 legs each

Algebra Evaluate each expression if $a = 4$ and $b = 5$.

13. $3 + a$

$3 + \underline{\phantom{0}} =$

14. $20 \div b + 5$

$\underline{\phantom{0}} + \underline{\phantom{0}} =$

Algebra Write an equation to represent each sentence.

15. If there are 7 cars on a roller coaster with 3 seats each and 2 seats are empty, then $m$ seats are full.

16. There are 2 vases with 3 flowers each and each flower has $m$ petals, so there are a total of 30 petals.

17. Bree counted 51 birds at the park. Twenty-seven were geese and the rest were ducks. The ducks flew away in groups of 8. How many groups of ducks were there? Write an equation with a letter for the unknown. Then solve.
Problem Solving

Algebra  Write an equation with a letter for the unknown for Exercises 18–19. Then solve.

18. The building manager put new door knobs on 4 doors in each apartment. There are 3 apartments on each floor and 3 floors in the apartment building. How many new door knobs did he install?

19. A soccer team scored 1 point. They scored four more points. The other team had twice as many points. How many points did the other team have?

20. Morgan needed to write an equation. Explain whether she actually wrote an equation.

Test Practice

21. Kayla is $x$ years old. Kevin is 3 years younger than Kayla. If $x = 12$, how old is Kevin?

- A 7 years old
- B 8 years old
- C 9 years old
- D 10 years old
Reflect

Use what you learned about properties and equations to complete the graphic organizer.

Real-World Problem

Distributive Property Example

Write an equation.

ESSENTIAL QUESTION
How are properties and equations used to group numbers?

Vocabulary

Associative Property Example

Write an equation.

Now reflect on the ESSENTIAL QUESTION ? Write your answer below.

560 Chapter 9 Properties and Equations