Chapter 4

Understand
Multiplication

ESSENTIAL QUESTION
What does multiplication mean?

My Favorite Foods

Watch a video!
Operations and Algebraic Thinking

3.OA.1 Interpret products of whole numbers, e.g., interpret \(5 \times 7\) as the total number of objects in 5 groups of 7 objects each.

3.OA.3 Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.

3.OA.5 Apply properties of operations as strategies to multiply and divide.

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
Find each sum.

1. \(2 + 2 + 2 + 2 = \)  
   \(4 + 4 = \)  
   \(5 + 5 + 5 = \)

4. \(10 + 10 + 10 + 10 = \)  
   \(0 + 0 + 0 = \)  
   \(1 + 1 + 1 = \)

Write an addition sentence for each picture.

7. \[ + + = \]

8. \[ + + = \]

Solve. Use repeated addition.

9. Larisa has 2 cups with 4 crackers in each cup. How many crackers does she have in all?

10. On Monday and Tuesday, Lance rode his bike around the block 3 times each day. How many times in all did he ride his bike around the block?

   crackers

   times
Review Vocabulary

number sentence  repeated addition  sum

Making Connections
Use the review words to label each example of addition in the graphic organizer. Use the second column to draw an example of the addition.

Label It

2 + 2 + 2 = 6

Draw It

3 + 3 + 3 + 3 = 12
**Lesson 4-3**

**array**

\[
\begin{array}{c}
4 \\
5
\end{array}
\]

\[4 \times 5 = 20\]

**Lesson 4-6**

**combination**

<table>
<thead>
<tr>
<th>pants</th>
<th>pants</th>
</tr>
</thead>
<tbody>
<tr>
<td>shirt</td>
<td>pants</td>
</tr>
<tr>
<td>shirt</td>
<td>pants</td>
</tr>
</tbody>
</table>

\[2 \times 2 = 4\]

**Lesson 4-1**

**Commutative Property of Multiplication**

\[3 \times 6 = 6 \times 3\]

**equal groups**

\[\text{Equal Groups} \]

**Lesson 4-2**

**factor**

\[1 \times 6 = 6\]

\[\text{Factor} \]

**multiplication sentence**

\[3 \times 5 = 15\]

**Lesson 4-1**

**multiply (multiplication)**

\[4 \times 5 = 20\]

**Lesson 4-2**

**product**

\[3 \times 4 = 12\]
Idea s for Use

- Group two or three related words. Add an unrelated word. Have another student identify which word is unrelated.
- Find pictures to show some of the words. Have a friend guess which word each picture shows.

A new set that has one item from each group of items.
What is the root word in combination? Write two other words using this root and different suffixes.

Objects or symbols displayed in rows of the same length and columns of the same length.
Disarray means “not orderly.” Write the prefix in disarray and its meaning.

Groups with the same number of objects.
Draw an example of 4 equal groups.

The property that states that the order in which two numbers are multiplied does not change the product.
What part of the word commutative means “to go back and forth”?

A number sentence using the × sign.
Write an example of a multiplication sentence. Then write the sentence using words.

A number that divides a whole number evenly. Also a number that is multiplied by another number.
Write a new word you can make from factor. Include the definition.

The answer to a multiplication problem.
Write a number sentence with a product of 6.

An operation on two numbers to find their product.
Write the root word of multiplication.
tree diagram

<table>
<thead>
<tr>
<th>Food</th>
<th>Color</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>apple</td>
<td>red</td>
<td>apple, red</td>
</tr>
<tr>
<td></td>
<td>green</td>
<td>apple, green</td>
</tr>
<tr>
<td>pepper</td>
<td>red</td>
<td>pepper, red</td>
</tr>
<tr>
<td></td>
<td>green</td>
<td>pepper, green</td>
</tr>
</tbody>
</table>
Ideas for Use

- Group two or three related words. Add an unrelated word. Have another student identify which word is unrelated.
- Find pictures to show some of the words. Have a friend guess which word each picture shows.

- Use the blank cards to write your own vocabulary cards.

A diagram of all the possible outcomes of an event or series of events or experiments. Explain how a tree diagram is like a tree.
How many combinations?

colors \times shapes = combinations
Hands On
Model Multiplication

Build It

When you have **equal groups**, you have the same number of objects in each group. Use repeated addition to find the total number of objects.

**Find the total in 4 equal groups of 5.**

1. Use connecting cubes to show 4 equal groups of 5 cubes. Draw the groups.
   
   There are ______ groups with ______ in each group.

2. Write the number of cubes in each group. Use repeated addition to complete the number sentence.

   \[ + + + + = \]

   The total in 4 groups of 5 is 20.

3. Record the number of groups, the number in each group, and the total from above.

   Explore other ways to group the 20 cubes equally.
You can also use **multiplication** to find the total number of objects in equal groups. A number sentence with the symbol \((\times)\) is called a **multiplication sentence**. It means to **multiply**.

**Try It**

Shawn helped his mom bake cookies. He served 4 cookies on each plate. There are 2 plates. How many cookies did he serve?

Find the total of 2 plates of 4 cookies.

1. Use counters to model the equal groups. Draw the groups.
2. Use repeated addition to complete the number sentence.
   
   \[ + = \]

3. Write a multiplication sentence to show 2 plates of 4 cookies, or 2 groups of 4.
   
   \[ \times = \]
   
   **number of groups** \(\times\) **number in each group** = **total**

So, Shawn served ___ cookies.

**Talk About It**

1. **Mathematical Practice**
   
   **Draw a Conclusion** How can addition help you find a total number of objects in equal groups?

2. How did you find the total number of cubes in Step 2 of the first activity?

3. Shawn counted a batch of cookies by finding \(4 + 4 + 4\). How could multiplication have helped him to find the total?

   What was the total?  

---

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Practice It

Draw a model to find the total number.

4. 6 groups of 2 equals

5. 3 groups of 5 equals

6. \(2 \times 4 = \)

7. \(1 \times 7 = \)

Describe each set of equal groups.

8. 

9. 

+ = 

+ + = 

groups of = 

groups of = 

10. \(8 \times 2 = \)

11. \(5 \times 5 = \)

groups of = 

groups of = 

Equally group the counters. Draw the equal groups.

12. set of 6 counters

13. set of 18 counters
Apply It

Mathematical Practice

Model Math

Draw to complete each model. Then complete each number sentence.

14. Tennis balls come in cans of 3.
   How many tennis balls are in 4 cans?
   
   
   
   = tennis balls

15. Sam has 2 celery sticks. Each stick is topped with peanut butter and 4 raisins. How many raisins does Sam have in all?

   
   
   = raisins

16. Use Number Sense
   Mary bought a box of 6 crayons. Then she bought 3 more boxes. How many crayons did she buy in all? How much money did she spend in all?

   
   
   
   = crayons;

Write About It

17. What does it mean to multiply?
Homework Helper

Gina put 3 scoops of frozen yogurt in each bowl. There are 6 bowls. How many scoops of frozen yogurt are there?

1. The model shows the total number of scoops.

   There are 6 bowls, and each has 3 scoops. There are 6 groups of 3.

2. Use repeated addition to find the total.

   \[3 + 3 + 3 + 3 + 3 + 3 = 18\]

   There are 18 scoops of frozen yogurt.

Practice

Draw a model to find the total number.

1. 2 groups of 8 equals

2. 5 groups of 7 equals

3. \[6 \times 4 = \]

4. \[4 \times 8 = \]
Describe each set of equal groups.

5. □ □ □  + □ □ □  + □ □ □  + □ □ □  =  
   groups of  =  

6. ★ ★ ★  + ★ ★ ★  + ★ ★ ★ =  
   groups of  =  

7. 6 × 5 =  
   groups of  =  

8. 3 × 4 =  
   groups of  =  

**Problem Solving**

Model Math Complete each number sentence.

9. Paulina played 3 soccer games on Saturday. She drank 1 juice box during each soccer game. How many juice boxes did she drink?
   
   +  +  =  juice boxes

10. Daniel, Jamie, Molly, and Corey each have 4 books from the library. How many books do they have in all?
    
    +  +  +  =  library books

**Vocabulary Check**

11. Choose the correct word(s) to complete the sentence below.
    equal groups     multiplication
    You can use    to find the total number of
    objects in

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Multiplication as Repeated Addition

There are many ways to find the total when there are groups of equal objects.

Example 1
Gilberto made 4 small pizzas for his party. Each pizza had 5 slices of tomato. How many slices of tomato did Gilberto use to make 4 small pizzas?

Find how many slices of tomato there are in 4 groups of 5.

One Way Draw a picture.

1. There are _____ groups. Draw 4 pizzas.

2. There are _____ in each group.
   Draw 5 slices of tomato on each pizza.

3. Count. There are _____ slices of tomato.

Another Way Use repeated addition. Write an addition sentence to show the equal groups.

_____ + _____ + _____ + _____ = _____

So, _____ groups of _____ is _____.

Gilberto used _____ slices of tomato.
When you find the total of equal groups of objects, you **multiply**. The symbol (×) means to multiply. The numbers multiplied are **factors**. The result is the **product**.

**Example 2**

A honeycomb cell has 6 sides. How many sides do 5 separated honeycomb cells have?

Find 5 groups of 6.

**One Way** Write an addition sentence.

Use five 6-sided pattern blocks. Count the number of sides in all.

\[ + + + + + = \]

**Another Way** Write a multiplication sentence.

\[
\text{number of cells (groups)} \times \text{number of sides} = \text{total}
\]

\[
\text{factor} \quad \times \quad \text{factor} = \text{product}
\]

Find the unknown, or missing value.

So, groups of 6 is . The unknown is sides.

**Guided Practice**

1. Write an addition sentence and a multiplication sentence.

\[ + + + + + = \]

\[ \times = \]

Can you write \(2 + 3 + 4 = 9\) as a multiplication sentence? Explain.
Independent Practice

Write an addition sentence and a multiplication sentence for each.

2. \[ \begin{array}{ccc} \text{butterflies} & \text{butterflies} & \text{butterflies} \\ + & + & = \\ \times & = \end{array} \]

3. \[ \begin{array}{ccc} \text{airplanes} & \text{airplanes} & \text{airplanes} \\ + & = \\ \times & = \end{array} \]

4. \[ \begin{array}{cccccc} \text{circles} & \text{circles} & \text{circles} & \text{circles} & \text{circles} & \text{circles} \\ + & + & + & + & + & + \\ \times & = \end{array} \]

5. \[ \begin{array}{ccccccc} \text{bugs} & \text{bugs} & \text{bugs} & \text{bugs} & \text{bugs} & \text{bugs} & \text{bugs} \\ + & + & + & + & + & + & + \\ \times & = \end{array} \]

Draw a picture to find the total. Write a multiplication sentence.

6. 6 groups of 5

7. 8 groups of 4

\[ \begin{array}{c} \times = \end{array} \]

Algebra Multiply to find the unknown product.

8. \(3 \times 5 = \) 9. \(5 \times 2 = \) 10. \(3 \times 3 = \)

The unknown is . The unknown is . The unknown is .
Algebra Write a multiplication sentence with a symbol for the unknown. Then solve.

11. Adriano bought 3 boxes of paints. Each box has 8 colors. What is the total number of colors?
   \[3 \times 8 = \square\]
   \[3 \times 8 = \square\] colors

12. Three boys each have 5 balloons. How many balloons do they have altogether?
   \[\square \times \square = \square\]
   \[\square \times \square = \square\] balloons

HOT Problems

Mathematical PRACTICE Model Math Write a real-world problem for the model. Write a multiplication sentence to find the total.

Mathematical PRACTICE Use Number Sense What is 2 more than 5 groups of 3?

15. Building on the Essential Question How are multiplication and repeated addition alike?
Homework Helper

Dani will put 2 forks at each of the 8 table settings. How many forks does she need in all?

Find 8 groups of 2.

Write an addition sentence to show the equal groups.

\[2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 = 16\]

Write a multiplication sentence to show 8 groups of 2.

\[8 \times 2 = \]

Find the unknown.

\[8 \times 2 = 16\]

So, 8 groups of 2 is 16. The unknown is 16 forks.

Practice

Write an addition sentence and a multiplication sentence for each.

1.  

\[\begin{align*}
6 & \ + \ 6 \\
6 & \ + \ 6 \\
6 & \ + \ 6 \\
6 & \ + \ 6
\end{align*}\]

\[6 + 6 + \_ + \_ + \_ = \]

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

2.  

\[\begin{align*}
\text{balloons} & \ + \ \text{balloons} \\
\text{balloons} & \ + \ \text{balloons} \\
\text{balloons} & \ + \ \text{balloons}
\end{align*}\]

\[\_ + \_ + \_ + \_ = \]

\[\_ \times \_ = \_\]
Problem Solving

Draw a picture to find the total. Write a multiplication sentence.

3. 7 groups of 1 green grape  
4. 9 groups of 2 square crackers

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

5. **Mathematical PRACTICE** **Model Math** How many buttons does Leonora have altogether if she has 4 bags of buttons and each bag has 10 buttons?

\[ \times = \]

Multiply to find the unknown product.

6. \[ 8 \times 3 = \]
7. \[ 4 \times 3 = \]

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

Vocabulary Check

Use the correct word(s) and the number sentence \( 6 \times 8 = 48 \) to solve.

- equal groups
- repeated addition
- multiply
- factors
- product

8. The number 48 is the ...
9. The symbol \( \times \) tells you to ...
10. The numbers 6 and 8 are the ...
11. \( 8 + 8 + 8 + 8 + 8 + 8 = 48 \) shows ...
12. \( 6 \times 8 \) means 6 ... of 8.

Test Practice

13. Sam is washing windows. There are 5 windows in each of 7 rooms. How many windows does Sam have to wash?

- A 2 windows
- B 12 windows
- C 30 windows
- D 35 windows
Hands On
Multiply with Arrays

Draw It

An **array** has rows of equal length and columns of equal length.

1. Make an array on a piece of paper. Arrange the tiles in 4 rows with 3 tiles in each row. Draw the array.

2. Count. What is the total number of tiles?

3. Turn your paper. There are now _____ rows with _____ tiles in each row.

   Draw what the array looks like now.

4. Count. What is the total number of tiles?

   So, there are the same number of tiles, _____, if you turn the array.
The **Commutative Property of Multiplication** states that the order in which numbers are multiplied does not change the product.

**Try It**

1. Use tiles to make an array on paper that has 5 rows of 2 tiles. Draw the array.

   Write an addition sentence to show equal rows.

   \[
   + + + + + =
   \]

   Write a multiplication sentence to represent the array.

   \[
   \text{rows} \quad \text{number in each row} \quad \text{total} \\
   \quad \times \quad =
   \]

2. Turn the array the other way. There are now ____ rows of ____ tiles. Draw the array.

   Write an addition sentence to show equal rows.

   \[
   + =
   \]

   Write a multiplication sentence to represent the array.

   \[
   \text{rows} \quad \text{number in each row} \quad \text{total} \\
   \quad \times \quad =
   \]

**Talk About It**

1. **Stop and Reflect** What is the connection between repeated addition and an array?

   

2. How can you use an array to model the Commutative Property?

   

3. List 3 everyday objects that are arranged in an array.
Practice It

Draw an array to find the product.

4. $4 \times 2 = \underline{\hspace{2cm}}$

5. $3 \times 5 = \underline{\hspace{2cm}}$

Write an addition sentence and a multiplication sentence to show equal rows.

6. 

\[
\begin{array}{cccc}
\square & \square & \square & \square \\
\square & \square & \square & \square \\
\square & \square & \square & \square \\
\end{array}
\]

\[\underline{\hspace{2cm}} + \underline{\hspace{2cm}} + \underline{\hspace{2cm}} + \underline{\hspace{2cm}} = \underline{\hspace{2cm}}
\]

\[\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}\]

7. 

\[
\begin{array}{cc}
\square & \square \\
\square & \square \\
\square & \square \\
\end{array}
\]

\[\underline{\hspace{2cm}} + \underline{\hspace{2cm}} + \underline{\hspace{2cm}} = \underline{\hspace{2cm}}
\]

\[\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}\]

8. 

\[
\begin{array}{c}
\square \\
\square \\
\square \\
\end{array}
\]

\[\underline{\hspace{2cm}} + \underline{\hspace{2cm}} = \underline{\hspace{2cm}}
\]

\[\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}\]

9. Use the Commutative Property of Multiplication to write another multiplication sentence for Exercise 8.

\[\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}\]


\[\underline{\hspace{10cm}}\]
Apply It

11. Marcos has 3 sheets of stickers. Each sheet has 4 stickers on it. Write a multiplication sentence to find how many stickers he has in all.

\[ \text{ } \times \text{ } = \text{stickers}\]

12. Circle the picture that does not represent an array. Explain.

![Array Pictures]

13. **Mathematical PRACTICE**

   **Keep Trying** Draw an array to find the unknown number in the multiplication sentence \(6 \times \text{ } = 18\).

Write About It

14. How can I use an array to model multiplication?
Homework Helper

James discovered that a sheet of stamps is in an array. The stamps are arranged in 6 equal rows of 3.

Write an addition sentence to show equal rows.

3 + 3 + 3 + 3 + 3 + 3 = 18

Write a multiplication sentence to represent the array.

<table>
<thead>
<tr>
<th>rows</th>
<th>number in each row</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>3</td>
<td>18</td>
</tr>
</tbody>
</table>

James turns the sheet of stamps the other way. There still are 18 stamps. Only now, there are 3 equal rows of 6.

Draw an array to find the product.

1. 5 × 7 = ________  
2. 6 × 5 = ________
Write an addition sentence and a multiplication sentence to show equal rows.

3.

4.

Vocabulary Check

5. Draw two arrays to model $2 \times 3 = 6$.
   Use the arrays to show the meaning of the Commutative Property of Multiplication.

Problem Solving

6. **Model Math** Suki's watercolor set has 3 rows of paint. There are 8 colors in each row. Write a multiplication sentence to find the total number of colors in the set.

7. A checkerboard has 8 rows, with 8 squares in each row. Write a multiplication sentence to find the total number of squares.
Arrays and Multiplication

An **array** is a group of objects arranged in equal numbered rows and equal numbered columns. Arrays can help you multiply.

**Math in My World**

**Example 1**

Mrs. Roberts baked a batch of bagels. She arranged the bagels in 3 equal rows of 4 bagels each on the cooling rack. How many bagels did she bake?

Find the total number of bagels. Use counters to model the array. Draw the array.

---

You can use repeated addition or multiplication to find the unknown.

**One Way** Add. \[\_\_\_ + \_\_\_ + \_\_\_ = \_\_\_\_\]

**Another Way** Multiply. \[\_\_\_ \times \_\_\_ = \_\_\_\_\]

So, \_\_\_ rows of \_\_\_ is \_\_\_ or \_\_\_ \times \_\_\_ = \_\_\_\_.

The unknown is \_\_. Mrs. Roberts baked 12 bagels.
Example 2

One page of Elsa’s photo album is shown. Write two multiplication sentences to find how many photos are on the page.

Key Concept  Commutative Property

Words  The Commutative Property of Multiplication says the order in which numbers are multiplied does not change the product.

| Examples | 4 × 2 = 8  | 2 × 4 = 8 |
|          | factor | factor | product | factor | factor | product |

Guided Practice

Write an addition sentence and a multiplication sentence to show equal rows.

1. □ + □ = □
   □ × □ = □

2. + □ = □
   □ × □ = □

What other operation uses the Commutative Property? Explain.
Independent Practice

Write an addition sentence and a multiplication sentence to show equal rows.

3.  

\[
\begin{array}{c}
\ + \\
\ + \\
\ + \\
\end{array}
\]

\[
\times =
\]

4.  

\[
\begin{array}{c}
\ + \\
\ + \\
\end{array}
\]

\[
\times =
\]

5.  

\[
\begin{array}{c}
\ + \\
\ + \\
\ + \\
\ + \\
\end{array}
\]

\[
\times =
\]

6.  

\[
\begin{array}{c}
\ + \\
\ + \\
\ + \\
\end{array}
\]

\[
\times =
\]

7.  

\[
\begin{array}{c}
\ + \\
\ + \\
\end{array}
\]

\[
\times =
\]

8.  

\[
\begin{array}{c}
\ + \\
\ + \\
\ + \\
\ + \\
\ + \\
\end{array}
\]

\[
\times =
\]

Use the Commutative Property of Multiplication to find each missing number.

9. \[5 \times 2 = \]

10. \[\_ \times 5 = 15\]

11. \[3 \times \_ = 27\]

\[
\begin{array}{c}
2 \times \\
\times 3 \\
9 \times 3 \\
\end{array}
\]

12. Hope drew the array at the right. Write a multiplication sentence to represent the model.

\[
\times =
\]
Problem Solving

For Exercises 13 and 14, draw an array to solve. Then write two multiplication sentences.

13. Bailey made a 3 by 4 array with her crackers. How many crackers does she have?

14. There are 4 waiters serving 5 tables each. How many tables do the waiters have altogether?

HOT Problems

15. **Mathematical PRACTICE** Reason Why do you sometimes have only one multiplication sentence for an array?

16. **Mathematical PRACTICE** Find the Error Alyssa is using the numbers 2, 3, and 6 to show the Commutative Property. Find and correct her mistake.

\[3 \times 2 = 6 \text{ so, } 6 \times 3 = 2\]

17. **Building on the Essential Question** How can the Commutative Property be used to write multiplication sentences?
The pumpkins in a patch are arranged in rows with an equal number in each row. How many pumpkins are in the patch?

Write an addition sentence and a multiplication sentence to show equal rows.

\[6 + 6 + 6 = 18 \quad 3 \times 6 = 18\]

The Commutative Property of Multiplication allows you to change the order of the factors to write another multiplication sentence, \(6 \times 3 = 18\).

There are 18 pumpkins in the pumpkin patch.

Practice

Write an addition sentence and a multiplication sentence to show equal rows.

1. \[\quad + \quad + \quad = \quad \]
   \[\quad \times \quad = \quad \]

2. \[\quad + \quad + \quad = \quad \]
   \[\quad \times \quad = \quad \]
Use the Commutative Property of Multiplication to find each missing number.

3. \(3 \times 2 = 6\) \(\quad\) \(\_\times 3 = 6\)
4. \(6 \times 4 = 24\) \(\quad\) \(4 \times \_ = 24\)
5. \(8 \times 6 = 48\) \(\quad\) \(6 \times 8 = \_\)
6. \(5 \times 2 = 10\) \(\quad\) \(\_ \times 5 = 10\)

**Problem Solving**

Draw an array to solve. Then write two multiplication sentences.

7. Bottles of syrup are arranged in 4 rows of 7 bottles each. How many bottles of syrup are there in all?

8. A parking lot has 6 rows of 10 spaces. How many parking spaces are there altogether?

**Vocabulary Check**

9. How can you use an array to show the Commutative Property?

**Test Practice**

10. Which pair of number sentences represents the Commutative Property of Multiplication?

   A. \(3 \times 6 = 18; 2 \times 9 = 18\)  
   B. \(6 \times 7 = 42; 7 \times 6 = 42\)  
   C. \(4 \times 5 = 20; 8 \times 5 = 40\)  
   D. \(9 + 11 = 20; 11 + 9 = 20\)
Vocabulary Check

Write the letter of the word that matches each definition or example.

A array

1. \(2 + 2 + 2 + 2 = 8\)

B Commutative Property of Multiplication

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

3. \(2 \times 4 = 8\)

C equal groups

4. This symbol \(\times\) means to _______.

D factors

5. An operation used to find the total number in equal groups.

E multiplication

6. \(5 \times 3 = 15\)

F multiplication sentence

7. \(3 \times 2 = 6\) \(2 \times 3 = 6\)

G multiply

8. _______

H product

9. _______

J repeated addition

Concept Check

Algebra  Circle equal groups. Find the unknown.

10. 2 groups of 4 = _______

2 groups of 4 = _______

11. 4 groups of 5 = _______

4 groups of 5 = _______
Use repeated addition to multiply.

12. $6 \times 2 = \underline{\hspace{2cm}}$

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

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

13. $2 \times 5 = \underline{\hspace{2cm}}$

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

Write an addition sentence and a multiplication sentence to show equal rows.

14.

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

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

15.

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

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

Problem Solving

16. Algebra Seven tigers each make 4 paw prints. How many paw prints are there altogether? Write a multiplication sentence with a symbol for the unknown. Then solve.

17. Adult tickets to the talent show cost $6. How much will 4 adult tickets cost? Draw an array to solve. Then write two multiplication sentences.

My Drawing!
Problem-Solving Investigation
STRATEGY: Make a Table

Learn the Strategy

Selma bought 3 shorts and 2 shirts. Laura, bought 4 shorts and 2 shirts. How many different shirt and shorts outfits can each girl make?

1. Understand
   What facts do you know?
   What do you need to find?
   How many different and outfits they each can make.

2. Plan
   Organize the information in a table of columns and rows.

3. Solve
   Make a table for each girl. List the possible shirt and shorts outfits.

<table>
<thead>
<tr>
<th>Selma</th>
<th>Shirt 1</th>
<th>Shirt 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorts A</td>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td>Shorts B</td>
<td>B1</td>
<td>B2</td>
</tr>
<tr>
<td>Shorts C</td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Laura</td>
<td>Shirt 1</td>
<td>Shirt 2</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Shorts A</td>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td>Shorts B</td>
<td>B1</td>
<td>B2</td>
</tr>
<tr>
<td>Shorts C</td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Shorts D</td>
<td>D1</td>
<td>D2</td>
</tr>
</tbody>
</table>

   So, Selma can make outfits, and Laura can make .

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

How many lunches can Malia make if she chooses one main dish and one side dish?

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 making a table.

1. Trey can choose one type of bread and one type of meat for his sandwich. How many different sandwiches can Trey make?

<table>
<thead>
<tr>
<th>Turkey</th>
<th>Chicken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
</tr>
</tbody>
</table>

Trey can make _______ sandwiches.

2. The students in Mr. Robb’s class are designing a flag. The flag’s background can be gold, red, or green. The flag can have either a blue or a purple stripe. Color all the possible flags.

<table>
<thead>
<tr>
<th>Blue</th>
<th>Purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td></td>
</tr>
</tbody>
</table>

They can design _______ flags.

3. **Mathematical PRACTICE Model Math** Tracy has a picture of her mom, a picture of her dad, and a picture of her dog. She has a black frame and a white frame. What is the question? Solve.

---

Lesson 5 Problem-Solving Investigation 221
4. Amber has coins in a jar. The sum of the coins is 13¢. What are the possible groups of coins Amber could have?

5. Solana buys 2 bags of salad mix for $8 and 3 pounds of fresh vegetables for $9. She gives the cashier $20. How much change will she receive?

6. **Be Precise** Mr. Grow has 12 tomato plants arranged in 2 rows of 6. List 2 other ways that Mr. Grow could arrange his 12 tomato plants in equal rows. Explain to a classmate how you got your answer.

7. **Use Math Tools** One campsite has 3 tents with 5 people in each tent. Another campsite has 3 tents with 4 people in each. How many campers are there in all? Draw an array to solve.
Jane’s new bike can have hand brakes or foot brakes. The bike can be silver, blue, black, or purple. How many possible bikes are there?

1. Understand
There are 2 types of brakes: hand brakes or foot brakes. There are 4 color choices: silver, blue, black, or purple.

I need to find the number of possible bikes.

2. Plan
Make a table.

3. Solve
There are 8 possible bikes.

4. Check
Multiply 2 types of brakes by 4 color choices. $4 \times 2 = 8$

Problem Solving

1. Solve the problem by making a table.

Claudio will decorate his bedroom. He can choose tan, blue, or gray paint and striped or plaid curtains. How many ways can he decorate his room with different paint and curtains?
Solve each problem by making a table.

2. Jimmy has a number cube labeled 1 through 6, and a penny. How many different ways can the cube and penny land with one roll of the cube and one flip of the penny?

<table>
<thead>
<tr>
<th>heads, (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>tails, (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

3. Archie earns $4 each week for doing his chores. How much money will Archie earn in 2 months if there are 4 weeks in each month?

<table>
<thead>
<tr>
<th>Month 1</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Time to do chores!

4. **Mathematical Practice** Identify Structure Abigail has a green, yellow, and purple shirt to match with either a white, black, or red pair of pants. How many different shirt and pants outfits can she make?

<table>
<thead>
<tr>
<th>pants, (w)</th>
<th>pants, (b)</th>
<th>pants, (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>shirt, (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shirt, (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shirt, (p)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How many outfits would be possible if Abigail had only 2 shirts and 2 pair of pants? Explain.
Use Multiplication to Find Combinations

When you make a **combination**, you make a new set that has one item from each group of items.

**Math in My World**

**Example 1**

Amos' team has 3 jersey colors: green, red, and yellow. They can wear orange or black shorts. Find all of the jersey and short combinations for the team.

1. Color the first jersey green, the second one red, and the last yellow.

2. Color 1 pair of shorts orange and 1 pair of shorts black below each jersey.

<table>
<thead>
<tr>
<th>Combinations</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jersey Colors</td>
<td>GREEN</td>
<td>GREEN</td>
<td>RED</td>
<td>RED</td>
</tr>
<tr>
<td>Shorts Colors</td>
<td>ORANGE</td>
<td>BLACK</td>
<td>ORANGE</td>
<td>ORANGE</td>
</tr>
</tbody>
</table>

Write a multiplication sentence.

\[ \text{jersey colors} \times \text{shorts colors} = \text{combinations} \]

Find the unknown.

So, there are \[ \text{jersey and shorts combinations possible.} \]
Another way to find combinations is to use a tree diagram. A **tree diagram** uses “branches” to show all possible combinations.

### Example 2
**What are all the possible fruit sorbet combinations if you choose one flavor and one fruit to add in?**

Complete the tree diagram.

<table>
<thead>
<tr>
<th>Flavors</th>
<th>Fruits</th>
<th>Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>mango</td>
<td>banana</td>
<td>mango, berries, peach</td>
</tr>
<tr>
<td>strawberry</td>
<td>banana</td>
<td>banana, berries</td>
</tr>
<tr>
<td>vanilla</td>
<td>banana</td>
<td></td>
</tr>
<tr>
<td></td>
<td>berries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>peach</td>
<td></td>
</tr>
</tbody>
</table>

**Check** Multiply to find the number of possible combinations.

\[ \text{flavors} \times \text{fruits} = \text{fruit sorbet combinations} \]

So, there are **possible fruit sorbet combinations.**

### Guided Practice
1. Refer to Example 2. How would the possible number of combinations change if one more flavor was added? Write the multiplication sentence.

\[ \_ \times \_ = \_]
Independent Practice

Find all the possible combinations. Write a multiplication sentence to check.

2. Jackie is playing a card game with triangles and circles. Each shape can be blue, red, yellow, or green. How many different cards are there?

<table>
<thead>
<tr>
<th>Shape</th>
<th>Color</th>
<th>Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>triangle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>circle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{number of triangles} \times \text{number of colors} = \text{different cards}
\]

3. List all of the 2-digit numbers that can be made with 3 or 4 as the tens digit and 1, 6, 7, 8, or 9 as the ones digit.

<table>
<thead>
<tr>
<th>Tens Digit</th>
<th>Ones Digit</th>
<th>Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{number of digits} \times \text{number of digits} = \text{numbers}
\]
Problem Solving

Write a multiplication sentence to solve the problem.

4. Madison needs to choose 1 breakfast item and 1 drink. Find the number of possible combinations.

\[ \times = \text{combinations} \]

<table>
<thead>
<tr>
<th>Breakfast Menu</th>
<th>Drink Menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancakes</td>
<td>Milk</td>
</tr>
<tr>
<td>Eggs, Bacon</td>
<td>Iced Tea</td>
</tr>
</tbody>
</table>

Suppose hot chocolate was added to the drink menu. How would the number of combinations change?

HOT Problems

5. Use Math Tools Write a real-world combination problem for the multiplication sentence \( 4 \times 2 = \) . Ask a classmate to solve with a tree diagram. Then find the unknown.

6. Building on the Essential Question How can multiplication help to find combinations?
Lucia’s three dogs have red, purple, blue, green, and orange collars that they take turns wearing. Find the number of possible dog and collar combinations.

Show all of the possible combinations.

There are 3 dogs and 5 collar colors.
3 × 5 = 15 possible combinations

Practice

1. Diana can take 1 pencil and 1 eraser to school. Her choices are shown. How many different pencil and eraser combinations are there? Complete the tree diagram. Write a multiplication sentence.
Identify Structure For a snack, Randy can choose from peanuts, carrots, or popcorn. He can have water or juice to drink. How many snack and drink combinations are there? Complete the tree diagram. Write a multiplication sentence.

<table>
<thead>
<tr>
<th>Snack</th>
<th>Drink</th>
<th>Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \quad \times \quad = \quad \text{combinations} \]

Vocabulary Check

3. Write the correct vocabulary word(s) in each space to complete the sentence.

combination tree diagram

Each branch of a tree diagram shows a possible ______ of items.

Test Practice

4. Amanda bought 4 pairs of shoes and 5 purses. Which number sentence shows the number of different shoes and purse combinations that Amanda can make?

- A) $4 + 5 = 9$
- C) $4 + 4 + 4 + 4 = 16$
- B) $5 \times 8 = 40$
- D) $4 \times 5 = 20$
Use the word bank to complete each sentence.

- array
- equal groups
- multiplication sentence
- tree diagram
- combination
- factor
- multiply
- Commutative Property
- multiplication
- product

1. An arrangement of objects into rows of equal length and columns of equal length is a(n) ____________.

2. The answer to a multiplication problem is the ____________.

3. ____________ is the operation of two numbers that can be thought of as repeated addition.

4. A number multiplied by another number is a ____________.

5. You can put equal groups together to ____________.

6. The ____________ says the order in which numbers are multiplied does not change the product.

7. A ____________ uses “branches” to show all possible combinations.

8. When you make a ____________ of items, you make a new set that has one item from each group.

9. When you have ____________, you have the same number of objects in each group.
Concept Check

Write an addition and a multiplication sentence to show equal rows.

10. \[
\begin{array}{ccc}
\text{ } & \text{ } & \text{ } \\
\text{ } & \text{ } & \text{ } \\
\end{array}
\]
\[
+ + = \\
\times =
\]

11. \[
\begin{array}{ccc}
\text{ } & \text{ } & \text{ } \\
\text{ } & \text{ } & \text{ } \\
\end{array}
\]
\[
+ = \\
\times =
\]

Write two multiplication sentences for each array.

12. \[
\begin{array}{ccc}
\text{ } & \text{ } & \text{ } \\
\text{ } & \text{ } & \text{ } \\
\end{array}
\]
\[
\times = \\
\times =
\]

13. \[
\begin{array}{ccc}
\text{ } & \text{ } & \text{ } \\
\text{ } & \text{ } & \text{ } \\
\end{array}
\]
\[
\times = \\
\times =
\]

14. Find the possible combinations of one yogurt and one topping. Complete the tree diagram. Write a multiplication sentence to check.

<table>
<thead>
<tr>
<th>Sundaes</th>
<th>Yogurt</th>
<th>Toppings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>strawberry</td>
<td>granola</td>
</tr>
<tr>
<td></td>
<td>peach</td>
<td>strawberries</td>
</tr>
<tr>
<td></td>
<td>vanilla</td>
<td></td>
</tr>
</tbody>
</table>

\[
\times = \text{ combinations}
\]
Problem Solving

15. There are 3 rows of 4 muffins. How many muffins altogether? Write two multiplication sentences.
   \[ \times = \]  
   \[ \times = \]

16. Toya finishes reading a book every 3 days. How many days does it take her to read 7 books? Complete the table to solve.

<table>
<thead>
<tr>
<th>Days</th>
<th>Books</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

So, it takes her ___ days to read 7 books.

Test Practice

17. Timmy downloaded 5 songs each day for five days. How many songs did he download during the 5 days altogether?
   A. 5 songs
   B. 10 songs
   C. 25 songs
   D. 35 songs
Reflect

Use what you learned about multiplication to complete the graphic organizer.

Draw Equal Groups

Real-World Problem

Vocabulary

Draw an Array

ESSENTIAL QUESTION

What does multiplication mean?

Chapter 4
Answering the ESSENTIAL QUESTION

Now reflect on the ESSENTIAL QUESTION

Write your answer below.