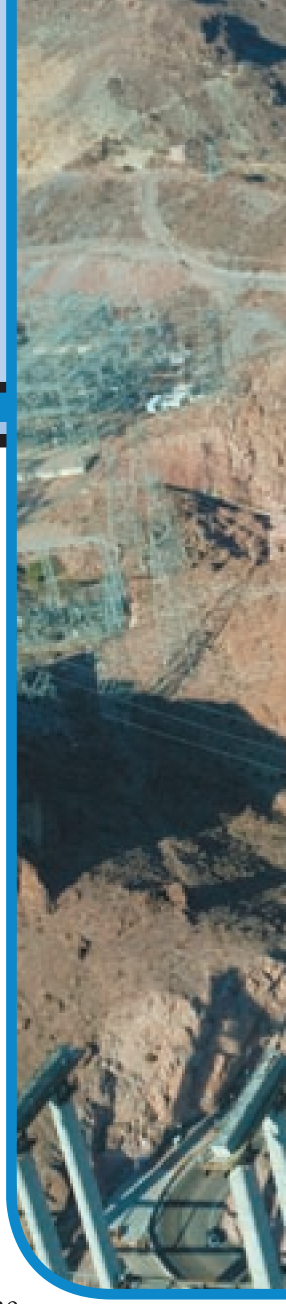


2 Multiply by a Whole Number

SAVED BY A STRANGER

Johnstown, Pennsylvania **May 31, 1889**

The South Fork Creek Dam near Pittsburgh, Pennsylvania, was built in the 1840s to furnish water for a canal between Johnstown and Pittsburgh. When train travel began in 1854, there was no further need for the canal, and the dam was neglected. A group of people from Pittsburgh's wealthy social class bought the lake, built summer resort homes around it, and formed a fishing and hunting club. In 1880, engineers from Cambria Iron Works became concerned about a small break and some rusted pipes in the dam. They sent the lake's owners a report explaining the repairs needed. But the owners did not heed the engineers' warnings and did nothing to repair the dam.

On May 31, 1889, after heavy rain, the South Fork Creek Dam burst, and a sweeping torrent of water rushed down the Allegheny mountainsides above Johnstown, Pennsylvania. The rushing water caught up everything in its current, including people, trees, animals, and buildings. By the time the current reached the little city in the valley, it was a raging river of debris from the mountain villages through which it had swept. People in Johnstown had to hold onto pieces of houses or whatever they could find to keep from being drowned in the flood.

Wreckage was piled up to the third story in one area of town.

One of these people was a six-year-old girl named Gertrude Quinn. A workman named Maxwell McAchren saw Gertrude on a mattress being swept along by the flood. Risking his own life, he dove from a large roof into the rushing water and struggled to swim to Gertrude. Finally, he managed to pull himself onto the mattress. Grateful to be rescued, Gertrude clung tightly to Maxwell. As they were swept near the shore, they noticed men on firm ground rescuing people from the floodwaters, but they were still too far from shore to be pulled to safety. Maxwell picked up the little girl and threw her to waiting men, just before the current swept the mattress and him away. He rode on the mattress for over four miles before he was rescued himself. Gertrude never saw Maxwell McAchren again, but she never forgot his kindness to her. Years later, she read of his death in a newspaper and sent red roses to the site of his grave.

Maxwell McAchren gives us a picture of the kind of love Jesus expects when He says, "Thou shalt love thy neighbour as thyself" (Mark 12:31). Maxwell loved his life, but he also loved the life of a little girl he had never met and was determined to do all he could to save her life as well as his own.

When the South Fork Creek Dam broke, 20 million tons of water were released.

Today, the Hoover Dam in Nevada has a reservoir (Lake Mead) with a capacity of 9.2 trillion gallons.

The Hoover Dam is 726.4 feet tall and was built with enough concrete ($4\frac{1}{2}$ million tons) to pave a sidewalk that is 4 feet wide around the earth's equator.

The base of the Hoover Dam is 660 feet thick, the length of two football fields.

Each penstock used to control the flow of water through the Hoover Dam can carry enough water to fill 960,000 twelve-ounce soda cans per second.

Today almost 1,000,000 people tour the Hoover Dam each year.

Multiply by a Whole Number

<table>
<tr><th>Lesson</th><th>Topic</th><th>Lesson Objectives</th><th>Chapter Materials</th></tr>
<tr><td>12</td><td>Multiplication</td><td>• Demonstrate an understanding of multiplication and the terms factor, product, and multiple
• Write a mathematical equation for a word phrase
• Solve multiplication equations with a multiplication dot, parentheses, or variables
• Identify prime and composite numbers
• Identify the Greatest Common Factor (GCF) and the Least Common Multiple (LCM) of a pair of numbers
• Apply properties of multiplication to numbers and variables: Commutative Property, Associative Property, Identity Property, and Zero Property</td><td rowspan="9">Teacher Manipulatives Packet:
• Place Value Kit
• Money Kit
Student Manipulatives Packet:
• Place Value Kit
• Money Kit
Instructional Aids (Teacher’s Toolkit CD):
• Cumulative Review Answer Sheet (page IA9) for each student
• Sieve of Eratosthenes (page IA10)
• Sieve of Eratosthenes (page IA10) for each student
• Apply Properties (page IA11)
• Powers of 10 (page IA12)
• Graph Paper (page IA13)
• Graph Paper (page IA13) for each student
• Perfect Squares & Square Roots (page IA14)
• Perfect Squares & Square Roots (page IA14) for each student
• Pictures of Multiplication (page IA15)
Christian Worldview Shaping (Teacher's Toolkit CD):
• Pages 4–6
Other Teaching Aids:
• Colored pencils: red and green for each student
• A sheet of graph paper for each student
• A calculator for each student (optional)
Math 6 Tests and Answer Key
Optional (Teacher’s Toolkit CD):
• Fact Review pages
• Application pages
• Calculator Activities</td></tr>
<tr><td>13</td><td>Multiples of 10</td><td>• Multiply multiples of 10
• Apply the Commutative and Associative Properties of Multiplication to multiply factors that are multiples of 10
• Analyze patterns for using mental math to multiply factors that are multiples of 10
• Apply the Distributive Property of Multiplication over Addition to multiply by multiples of 10
• Identify the applied addition or multiplication property</td></tr>
<tr><td>14</td><td>Exponents</td><td>• Develop an understanding of exponents
• Develop an understanding of squares
• Write numbers in expanded form with multiplication using exponents (powers of 10)</td></tr>
<tr><td>15</td><td>1- & 2-Digit Multipliers</td><td>• Multiply a whole number by a 1- or 2-digit multiplier
• Apply the Distributive Property of Multiplication over Addition
• Estimate the product by rounding to the place of greatest value and by using front-end estimation
• Solve a multiplication word problem</td></tr>
<tr><td>16</td><td>Multiply Decimals by a Whole Number</td><td>• Multiply a decimal by a 1- or 2-digit multiplier
• Estimate the product by rounding to the place of greatest value
• Apply the Distributive Property of Multiplication over Addition
• Solve decimal word problems, including money problems
• Solve a multi-step word problem
• Multiply a decimal by a power of 10</td></tr>
<tr><td>17</td><td>3-Digit Multipliers</td><td>• Multiply by a 3-digit multiplier
• Estimate the product by rounding to the place of greatest value
• Solve a money multiplication problem
• Determine the number of partial products
• Apply strategies to multiply mentally</td></tr>
<tr><td>18</td><td>Squares & Square Roots</td><td>• Develop an understanding of finding perfect squares
• Develop an understanding of finding the square root of a perfect square
• List the first 20 perfect squares and their square roots
• Use the Pythagorean Theorem to find the measurement of the hypotenuse of a right triangle</td></tr>
<tr><td>19</td><td>Chapter 2 Review</td><td>• Review</td></tr>
<tr><td>20</td><td>Chapter 2 Test Cumulative Review</td><td>• Identify the addition property applied to an equation
• Add and subtract whole numbers
• Solve for the variable in a subtraction equation
• Identify the standard form of a whole number or a decimal written in expanded form or word form
• Determine the decimal represented by a point on a number line
• Solve for the variable in a part-whole model
• Read and interpret a pictograph</td></tr>
</table>

As you prepare the lessons, you will want to refer to the corresponding Instructional Aids pages located on the Teacher’s Toolkit CD. If a page is not specified for the student’s or teacher’s use in the Chapter Materials list above, you should prepare the page for display.

The Charts and some of the visuals from the Math 4–6 Teacher Manipulatives Packet are located in the Teaching Visuals section of the Teacher’s Toolkit CD. Copies of the visuals may be prepared by home educators or by classroom teachers for individual or classroom (group) use.

A Little Extra Help

Use the following to provide "a little extra help" for the student that is experiencing difficulty with the concepts taught in Chapter 2.

Align columns—To facilitate alignment when solving multiplication problems, allow the student to use graph paper or lined notebook paper turned sideways, or provide copies of the Graph Paper page (page IA13 of the Instructional Aids section of the Teacher's Toolkit CD).

Solve multiplication problems with a 2- or 3-digit multiplier—Provide the student with 1 one square from the Place Value Kit in the Student Manipulatives Packet. Write a problem with a 2-digit multiplier on a sheet of paper. Direct the student to cover the digit in the Tens place of the multiplier with the one square to help him focus only on the first step for solving the problem. After he multiplies by the ones, instruct him to cover the digit in the Ones place of the multiplier and to multiply by the tens.

$$\begin{array}{r} {\scriptstyle 6\ 2\ } \\ 394 \\ \times\ \square 7 \\ \hline 2{,}758 \end{array}$$

Follow the same procedure for problems with a 3-digit multiplier; the student will need 2 one squares. Instruct the student to cover the digits that he is not multiplying by as he solves the problem.

Multiply a decimal by a whole number—Instruct the student to rewrite the multiplication problem without the decimal point in the decimal factor. Direct him to multiply as if both factors are whole numbers and to solve the problem. Next, direct the student to count the number of decimal places in the decimal factor of the original problem and to write the decimal point in the product; remind him that the number of decimal places in the product is the same as the number of decimal places in the decimal factor.

Math Facts

Throughout this chapter, review addition and subtraction facts using Fact Review pages or a Fact Fun activity on the Teacher's Toolkit CD, or you may use flashcards.

Lesson 12

Student Text pp. 28–31

Daily Review p. 406a

Objectives

- Demonstrate an understanding of multiplication and the terms *factor, product,* and *multiple*
- Write a mathematical equation for a given picture or word phrase
- Solve multiplication equations with a multiplication dot, parentheses, or variables
- Identify prime and composite numbers
- Identify the Greatest Common Factor (GCF) and the Least Common Multiple (LCM) of a pair of numbers
- Apply properties of multiplication to numbers and variables: Commutative Property, Associative Property, Identity Property, and Zero Property

Teacher Materials

- Place Value Kit: tens and ones
- Sieve of Eratosthenes, page IA10 (CD)
- Apply Properties, page IA11 (CD)

Student Materials

- Sieve of Eratosthenes, page IA10 (CD)
- Colored pencils: red and green

Note

Preview the Fact Review pages, the Application pages, and the Calculator Activities located on the Teacher's Toolkit CD.

Introduce the Lesson

Guide the students in reading aloud the story and facts on pages 28–29 of the Student Text (pages 26–27 of this Teacher's Edition).

Teach for Understanding

Demonstrate an understanding of multiplication

1. Display 3 sets of 24 (2 tens and 4 ones).
   ➤ **What addition equation can you write for this picture?** ***24 + 24 + 24 = 72*** **multiplication equation?** ***3 × 24 = 72***
   Write the equations for display.
   Display another 3 sets, using tens and ones: a set of 12, a set of 10, and a set of 9.
   ➤ **What addition equation can you write for this picture?** ***12 + 10 + 9 = 31*** **multiplication equation?** ***none*** **Why?** ***Elicit that multiplication is used to express a repeated addend.***
   Point out that multiplication is referred to as *repeated addition*.
2. Write *addend* + *addend* + *addend* = *sum* and *factor* × *factor* = *product* below the appropriate equations. Explain that, typically, when multiplication is pictured, the first factor is the *multiplier*; it tells the number of sets. The second factor is the *multiplicand*; it tells the number in each set. The *product* is the total; it is found by multiplying the two factors.
   ➤ **What are the factors in 3 × 24 = 72?** ***3 and 24*** **Which factor is the multiplier?** ***3*** **What does it tell you?** ***There are 3 sets.*** **Which factor is the multiplicand?** ***24*** **What does it tell you?** ***There are 24 in each set.*** **What is the product?** ***72*** **What does it represent?** ***the total or the answer to the multiplication equation***
3. Direct the students to write a multiplication equation with the first factor as the multiplier (number of sets) and the second factor as the multiplicand (number in each set) for these statements.
   3 plates of 7 cookies ***3 × 7 = 21***
   5 rows of 6 chairs ***5 × 6 = 30***
   2 dimes in each of 4 pockets ***4 × 2 = 8***
   6 chairs at each of 4 tables and 2 more chairs ***(4 × 6) + 2 = 26***
   Point out that although the Commutative Property states that the order of the factors does not affect the product, the order is important when representing a picture: the first factor expresses the number of sets, and the second factor expresses the number in each set.
4. Write 8 × 9 = 72; 3 • 7 = 21; and (5)(2) = 10 for display. Explain that a times sign, a dot, or parentheses can be used to indicate the multiplication of 2 factors. Read each equation aloud, using the word *times*.
   Write these equations for display. Select students to read the equations aloud and to write the products.
   8 • 6 = ***48*** (9)(7) = ***63*** 12 • 6 = ***72*** (5)(11) = ***55***
5. Write the following equations for display. Explain that when one or both of the factors is a variable, the factors can be written side by side with the whole number preceding the variable. Guide the students in solving these equations if a = 5 and b = 10.
   $7b$ = ***70*** ab = ***50*** $4a$ = ***20*** $2b - a$ = ***15***

Identify prime and composite numbers; identify the GCF and the LCM for a pair of numbers

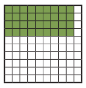
1. Explain that numbers greater than 1 are classified as *prime* or *composite*. Elicit that numbers with only 2 factors, 1 and the number itself, are prime numbers, and numbers with more than 2 factors are composite numbers. Guide the students in listing the factors of 2, 3, 4, 6, and 12 and in classifying each number as prime or composite.
   2: ***1, 2; prime*** 3: ***1, 3; prime***
   4: ***1, 2, 4; composite*** 6: ***1, 2, 3, 6; composite***
   12: ***1, 2, 3, 4, 6, 12; composite***
   Guide the students in identifying common factors and the greatest common factor (GCF) of any pair of the numbers (i.e., 6 and 12: 1, 2, 3, 6; GCF: 6).
2. Explain that *multiples* of a number are found when a number is multiplied by whole numbers (0, 1, 2, 3, 4 . . .). You can find the multiples of a number by *counting by* that number, beginning with zero.
   Guide the students in listing the first 12 nonzero multiples of 2, 4, and 6 and in circling in red the common multiples of 2 and 4. ***4, 8, 12, 16, 20, 24***
   2: ***2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24***
   4: ***4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48***
   6: ***6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72***
   ➤ **Why do you think every multiple of 4 is common to every other multiple of 2?** ***Elicit that every set of 4 is made up of 2 sets of 2.***
   Guide the students in circling in green the common multiples of 2 and 6. ***6, 12, 18, 24***
   ➤ **Why do you think every multiple of 6 is common to every third multiple of 2?** ***Elicit that every set of 6 is made up of 3 sets of 2.***
   ➤ **What do you predict about the common multiples of 8 and 2? Why?** ***Elicit that every multiple of 8 is common to every fourth multiple of 2 because every set of 8 is made up of 4 sets of 2.***

Multiplication

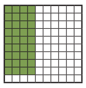
Multiplication is a form of addition. It is used to find the **product** (total) when equal sets are joined. The first **factor** of a multiplication equation tells the number of sets; the second **factor** tells the size of each set. When illustrating or writing an equation for a word problem or phrase, determine the number of sets and how many are in each set.

multiplication
factor × factor = product
multiple
multiplication properties
prime number
composite number
common factor
greatest common factor

$4 \times 9 = 36$
(4 sets of 9)



$9 \times 4 = 36$
(9 sets of 4)



A **multiple** is the product of a whole number and any given number.

- The first four nonzero multiples of 3 are 3, 6, 9, and 12.
- The first four nonzero multiples of 4 are 4, 8, 12, and 16.
- 12 is a multiple of both 3 and 4.

A multiplication equation can be written several ways. In the following problems, 3 and 4 are known factors, a is an unknown factor, and 12 is the product.

$4 \times 3 = 12$ $\quad 3 \cdot 4 = 12$ $\quad 3a = 12$ $\quad 3(4) = 12$

Properties of Multiplication

Commutative Property
The order of factors can be changed without changing the product.

$4 \times 6 = 6 \times 4$
$24 = 24$
$a \cdot b = b \cdot a$

Identity Property
When 1 is a factor, the product is the same as the other factor.

$6 \times 1 = 6$
$a \cdot 1 = a$

Zero Property
When 0 is a factor, the product is always 0.

$4 \times 0 = 0$
$a \cdot 0 = 0$

Associative Property
The grouping of factors can be changed without changing the product.

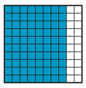
$(6 \times 4) \times 5 = 6 \times (4 \times 5)$
$24 \times 5 = 6 \times 20$
$120 = 120$
$(a \cdot b) \cdot c = a \cdot (b \cdot c)$

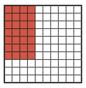
Distributive Property
The product of any 2 factors can be found by separating 1 factor into parts or addends. Multiply each part or addend by the other factor and add the partial products.

$6 \times 27 =$
$6 \times (20 + 7) =$
$(6 \times 20) + (6 \times 7) =$
$120 + 42 = 162$

Exercises

Write a multiplication equation for the picture. Solve.

1. 
10 × 8 = 80

2. 
7 × 4 = 28

3. 
3 × 6 = 18

4.

30				
6	6	6	6	6

5 × 6 = 30

Write a multiplication equation for the phrase. Solve. Draw a picture to illustrate. *Pictures may vary.*

5. 4 bags of 11 rubber bands *4 × 11 = 44 rubber bands*
6. 9 cornstalks in each of 7 rows *7 × 9 = 63 cornstalks*
7. 6 pizzas cut into 8 pieces each *6 × 8 = 48 pieces*
8. 3 boxes of a dozen doughnuts *3 × 12 = 36 doughnuts*
9. 7 packages of 15 pencils *7 × 15 = 105 pencils*
10. 23 students in each of 5 rooms *5 × 23 = 115 students*

30 Chapter 2

Solve.

11. 5×8 *40*
12. 3×7 *21*
13. 10×9 *90*
14. 12×4 *48*
15. 11×6 *66*
16. 7×7 *49*
17. 9×4 *36*
18. 6×1 *6*
19. 8×2 *16*
20. 0×3 *0*

Use the multiplication properties to write the missing number.

21. $15 \times (10 \times 8) = (15 \times \underline{10}) \times 8$
22. $4{,}937 \times \underline{1} = 4{,}937$
23. $492 \cdot 374 = 374 \cdot \underline{492}$
24. $12 \times \underline{12} = 12 \times (10 + 2)$
25. $5{,}431 \times \underline{0} = 0$
26. $4 \times 27 = 4 \times (\underline{20} + 7)$

Use the Associative Property and/or the Commutative Property to solve. Show your grouping. *Answers may vary.*

27. $2 \times (7 \times 5)$ *$(2 \times 5) \times 7 = 70$*
28. $(2 \times 9) \times 3$ *$(2 \times 3) \times 9 = 54$*
29. $2 \times (2 \times 8)$ *$(2 \times 2) \times 8 = 32$*
30. $(5 \times 4) \times 3$ *$(4 \times 3) \times 5 = 60$*

Use the Distributive Property to solve.

31. 6×12
32. 8×15
33. 4×23
34. 5×17

A **prime number** has exactly two different factors: 1 and itself.
A **composite number** has more than two factors.

List all the pairs of factors whose product is that number. Compare the factors of two numbers to find **common factors** and the **greatest common factor**.

Remember:
Because 1 is a factor of all numbers, it is not listed as a common factor.

Number	Factor pairs	Factor order	Type of number
29	1 × 29	1, 29	prime
18	1 × 18 2 × 9 3 × 6	1, 2, 3, 6, 9, 18	composite
42	1 × 42 2 × 21 3 × 14 6 × 7	1, 2, 3, 6, 7, 14, 21, 42	composite

Common factors of 18 and 42: 2, 3, and 6
Greatest common factor (GCF): 6

Exercises

Write the factor pairs for the numbers that are composite. Write prime if there are no other factors.

35. 9 — 1 × 9 *3 × 3*
36. 12 — 1 × 12 *2 × 6; 3 × 4*
37. 11 — 1 × 11 *prime*
38. 36 — 1 × 36 *2 × 18; 3 × 12; 4 × 9; 6 × 6*
39. 24 — 1 × 24 *2 × 12; 3 × 8; 4 × 6*

Practice & Application

40. What are the common factors of 12 and 24? 12 and 36? *2, 3, 4, 6, 12; 2, 3, 4, 6, 12*
41. What is the greatest common factor of 9 and 12? 24 and 36? *3; 12*
42. List the first twelve nonzero multiples of 3, 6, and 9.
43. Circle the common multiples of 3 and 9 in green.
44. Circle the common multiples of 3 and 6 in red.
45. Will the next multiple of 3 be a common factor of 6 or 9? Explain your answer.
46. The first four prime numbers are 2, 3, 5, and 7. There are four more prime numbers less than 20. What are they? *11, 13, 17, 19*

J Explain the relationship between the numbers 3 and 6. Use the terms *multiple* and *factor*. *The numbers 3 and 6 are related because 6 is a multiple of 3 and 3 is a factor of 6.*

Complete DAILY REVIEW a on page 406.

Lesson 12 31

3. Guide the students in identifying the least common multiple (LCM) of 2 and 4 *4*, 2 and 6 *6*, 4 and 6 *12*, and 2, 4, and 6 *12*. Model the strategy of counting by the largest of the numbers until you come to a multiple that is common to the other number(s). Point out that although 0 is a common multiple of all numbers, it is not used as the LCM.
4. Follow a similar procedure to list the multiples of 5 and identify the LCM of 4 and 5. *5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60; LCM: 20*
5. Point out that, although a common multiple of 2 numbers can be found by multiplying the 2 numbers, the product is not always the LCM.
6. Display and distribute the Sieve of Eratosthenes page. Explain that Eratosthenes was a mathematician who devised a system for finding prime numbers. Use the directions on Student Text page 259 to guide the students in identifying the prime numbers between 1 and 200.

Apply properties of multiplication

1. Lead a discussion to review the Commutative, Associative, and Identity Properties of Addition. (See Lesson 5.) Ask the students which of these properties could also apply to multiplication. Choose students to write a multiplication equation to prove their thinking.
2. Display the Apply Properties page. Lead a discussion of the first four properties represented by variables. Emphasize the purpose of these properties as follows: Commutative—order, Associative—grouping, and Identity—restates its name. Guide the students to the conclusion that these properties do not apply to subtraction or division (e.g., $3 - 2 \neq 2 - 3$ and $3 \div 1 \neq 1 \div 3$). Elicit that the Zero Property applies to multiplication.
3. Direct attention to the Distributive Property. Explain that the Distributive Property of Multiplication over Addition states that the product of 2 factors can be found by separating one factor into parts (addends), multiplying each part by the other factor, and adding the partial products.

   Write 16×23 for display and elicit ways to separate one of the factors into parts (addends). Demonstrate solving the equations as shown below. Point out that the products are the same (368). *Possible answers:*

$= (8 + 8) \times 23$	*$= 16 \times (20 + 3)$*
$= (8 \times 23) + (8 \times 23)$	$= (16 \times 20) + (16 \times 3)$
$= 184 + 184$	$= 320 + 48$
$= 368$	$= 368$

4. Choose students to tell the value of n in problems 1–8 and to identify the property they used to determine the value.
   1. *n = 45; Commutative Property of Multiplication*
   2. *n = 0; Identity Property of Addition*
   3. *n = 0; Zero Property of Multiplication*
   4. *n = 7; Associative Property of Multiplication*
   5. *n = 21; Associative Property of Addition*
   6. *n = 50; Commutative Property of Multiplication*
   7. *n = 10; Distributive Property*
   8. *n = 11; Distributive Property*

Student Text pp. 30–31

Lesson 13 | **Student Text** pp. 32–33
Daily Review p. 407b

Objectives
- Multiply multiples of 10
- Apply the Commutative and Associative Properties of Multiplication to multiply factors that are multiples of 10
- Analyze patterns for using mental math to multiply factors that are multiples of 10
- Apply the Distributive Property of Multiplication over Addition to multiply by multiples of 10
- Identify the addition or multiplication property applied in an equation

Teacher Materials
- Place Value Kit

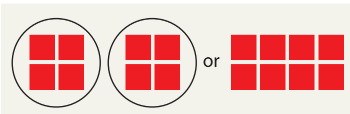
Student Materials
- Place Value Kit

Note
In this lesson, 10; 100; 1,000; 10,000; and 100,000 are referred to as *multiples of 10*. In Lesson 14 the students will learn that these numbers are also *powers of 10*.

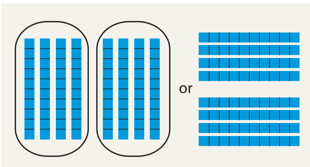
Teach for Understanding

Apply multiplication properties and analyze patterns to multiply by a multiple of 10

1. Write $2 \times 4 = \_$ for display. Direct the students to use the ones from their Place Value Kit to picture the equation and solve for the product. Remind the students that the first factor is the *multiplier* (it tells the number of sets), and the second factor is the *multiplicand* (it tells the number in each set). ***2 sets of 4 ones; 8*** Write the product, 8.



2. Repeat the procedure for $2 \times 40 = \_$ using the tens. ***2 sets of 4 tens; 80*** Write the product, 80. Guide the students in writing below 2×40 an expression with 3 factors for this picture, 1 of the factors being a multiple of 10. ***$2 \times (4 \times 10)$.***



3. Point out that $2 \times (4 \times 10)$ represents the same picture and has the same value as 2×40. Explain that the parentheses tell you to first make 4 sets of 10. Choose a student to display 4 sets of 10 or 4 tens.
   Explain that the 2 outside the parentheses tells you that there are 2 sets of the 4 sets of 10. Choose another student to display a second set of 4 tens.
   - ➤ **Are the pictures the same?** ***yes*** **Has the value changed?** ***no***
   - ➤ **How could you use the Associative Property to regroup the factors in $2 \times (4 \times 10)$?** ***$(2 \times 4) \times 10$*** Write $(2 \times 4) \times 10 = \_$ below $2 \times (4 \times 10) = \_$.
   Point out that first multiplying the digits that make a fact and then multiplying by a multiple of 10 can make multiplying mentally easier.
   - ➤ **What is 2×4?** ***8*** **What is 8×10?** ***80*** Write the product.
4. Follow a similar procedure for these equations.
   (*Note:* Since the student Place Value Kit contains only 1 thousand cube, select a student to use your thousand cubes to picture $2 \times 4{,}000 = \_$ for display.)
   $2 \times 400 = \_$ ***2 sets of 4 hundreds; 800; $2 \times (4 \times 100) = (2 \times 4) \times 100$***
   $2 \times 4{,}000 = \_$ ***2 sets of 4 thousands; 8,000; $2 \times (4 \times 1{,}000) = (2 \times 4) \times 1{,}000$***
   - ➤ **What do you notice about the product of these equations when one of the factors is a multiple of 10?** ***Elicit that the product of the fact, 2×4, is followed by the number of zeros in the multiple of 10.***
5. Explain that you can mentally multiply by multiples of 10; 100; and 1,000 by first grouping and multiplying the nonzero digits to make a fact, and then annexing the appropriate number of zeros.
   - ➤ **Write these equations for display and direct the students to solve them mentally.**

$4 \times 20 =$ ***80***	$3 \times 200 =$ ***600***	$2 \times 3{,}000 =$ ***6,000***
$2 \times 50 =$ ***100***	$4 \times 600 =$ ***2400***	$6 \times 5{,}000 =$ ***30,000***

6. Use hundreds from the Place Value Kit to display a 20×30 array (2 rows of 3 hundreds) as shown on Student Text page 32.
   - ➤ **What equation can you write for this array? Why?** ***Elicit $20 \times 30 = \_$; there are 20 rows with 30 squares (ones) in each row.*** Write the equation for display.
   - ➤ **How is this equation different from the equations you have already solved?** ***Answers may vary, but elicit that both factors are multiples of 10.***
   - ➤ **What is 20×30?** ***600*** Write the product.
7. Turn the array $\frac{1}{4}$ of a turn to the right. Guide the students in writing an equation for the new picture. ***$30 \times 20 = 600$***
   - ➤ **Did the factors or the product change?** ***no*** **What did change?** ***Elicit the order of the factors and the picture.***
   - ➤ **What property tells you that the order of the factors does not affect the product?** ***Commutative Property of Multiplication***
   - ➤ **What multiplication expressions, using expanded form, can you write for the factors 20 and 30?** ***Elicit 2×10 and 3×10.*** Write $(2 \times 10) \times (3 \times 10) =$ below 20×30 as shown on Student Text page 32.
   - ➤ **How can you use the Commutative and Associative Properties (to reorder and regroup the factors) to show the fact and the multiple of 10 that will help you solve this problem mentally?** ***Elicit $(2 \times 3) \times (10 \times 10)$.*** Write the expression and guide the students in solving it mentally. ***$6 \times 100 = 600$***
8. Follow a similar procedure for 30×40. ***1,200***
   - ➤ **What pattern do you notice in the product when both factors are multiples of 10?** ***Elicit that the product of the fact is followed by the total number of zeros in both factors.***
9. Write for display $10 \times 10 = 100$; $10 \times 100 = 1{,}000$; and $100 \times 1{,}000 = 100{,}000$. Point out the same pattern of zeros in these products.
10. Write these equations. Guide the students in solving them mentally and telling how they applied the Commutative and Associative Properties. Possible strategies are provided.
    $30 \times 50 =$ ***1,500; $(3 \times 5) \times (10 \times 10) = 15 \times 100$***
    $40 \times 700 =$ ***28,000; $(4 \times 7) \times (10 \times 100) = 28 \times 1{,}000$***
    $600 \times 300 =$ ***180,000; $(6 \times 3) \times (100 \times 100) = 18 \times 10{,}000$***
    $20 \times 9{,}000 =$ ***180,000; $(2 \times 9) \times (10 \times 1{,}000) = 18 \times 10{,}000$***

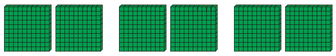
Multiples of 10

Knowing **multiples of 10** helps you apply multiplication properties and use **mental math** to solve multiplication problems.

multiples of 10
mental math

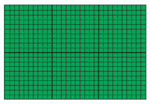
$10 \times 10 = 100$ $10 \times 100 = 1{,}000$ $10 \times 1{,}000 = 10{,}000$
$100 \times 100 = 10{,}000$ $100 \times 1{,}000 = 100{,}000$

The Associative Property and the Commutative Property allow numbers to be rearranged to find a product.



$3 \times 200 =$
$3 \times (2 \times 100) =$
$(3 \times 2) \times 100 =$
$6 \times 100 = 600$

Fact: $3 \times 2 = 6$



$20 \times 30 =$
$(2 \times 10) \times (3 \times 10) =$
$(2 \times 3) \times (10 \times 10) =$
$6 \times 100 = 600$

Fact: $2 \times 3 = 6$

When multiplying a factor times a multiple of 10, 100, or 1,000:
1. Multiply the basic fact.
2. Write the same number of zeros in the product as the number of zeros in the multiple of 10, 100, or 1,000.

When both factors are multiples of 10, 100, or 1,000:
1. Multiply the basic fact.
2. Write the number of zeros that are in both factors combined.

Exercises

Use the Associative Property and the Commutative Property to complete the equation. Show your grouping.

1. $3 \times 20 =$ $3 \times (2 \times 10) =$
2. $4 \times 50 =$ $4 \times (5 \times 10) =$
3. $70 \times 90 =$ $(7 \times 10) \times (9 \times 10) =$
4. $30 \times 800 =$ $(3 \times 10) \times (8 \times 100) =$

Use mental math to solve. Write only the answer.

5. 4×20 ***80***
6. 40×20 ***800***
7. $40 \times 2{,}000$ ***80,000***
8. 30×60 ***1,800***
9. 30×600 ***18,000***
10. 300×600 ***180,000***
11. 70×8 ***560***
12. 50×700 ***35,000***
13. 40×90 ***3,600***
14. 600×10 ***6,000***
15. 40×500 ***20,000***
16. 80×800 ***64,000***

Choose an expression for the phrase. Solve and write the label.

20×40 2×400 200×4 40×20 4×20

17. the total weight of four pumpkins weighing twenty pounds each ***4 × 20 = 80 pounds***
18. four pumpkins given to each of the two hundred workers ***200 × 4 = 800 pumpkins***
19. the pumpkin patch visited by forty groups of twenty students ***40 × 20 = 800 students***
20. twenty containers with forty pumpkins in each ***20 × 40 = 800 pumpkins***
21. two days of four hundred visitors at the pumpkin patch ***2 × 400 = 800 visitors***

32 Chapter 2

The Distributive Property can be used to find the product mentally when one factor is a multiple of 10.

$20 \times 17 =$
$20 \times (10 + 7) =$
$(20 \times 10) + (20 \times 7) =$
$200 + 140 = 340$

$42 \times 500 =$
$(40 + 2) \times 500 =$
$(40 \times 500) + (2 \times 500) =$
$20{,}000 + 1{,}000 = 21{,}000$

$20 \times 325 =$
$20 \times (300 + 20 + 5) =$
$(20 \times 300) + (20 \times 20) + (20 \times 5) =$
$6{,}000 + 400 + 100 = 6{,}500$

Exercises

Use the Distributive Property to solve. Write all of the steps.

22. 40×68
23. 200×13
24. 75×300
25. 20×415
26. 21×50
27. 80×110
28. 40×92
29. 16×30

Practice & Application

30. Write the next three numbers in the pattern: 3,460; 3,471; 3,482; 3,493. ***3,504; 3,515; 3,526***

31. Write a multiplication equation for the addition equation. Solve.
$45 + 45 + 45$ ***3 × 45 = 135***

32. Solve. Use the Commutative Property to write the equation another way.
30×4 ***120*** 12×20 ***240*** 400×60 ***24,000***

33. What addition equation could be written for 6×45? ***45 + 45 + 45 + 45 + 45 + 45***

34. Write the factor pairs for the products 15, 18, and 27.
15: 1 × 15; 3 × 5 18: 1 × 18; 2 × 9; 3 × 6 27: 1 × 27; 3 × 9

35. List the factors in order for 15, 18, and 27.
15: 1, 3, 5, 15 18: 1, 2, 3, 6, 9, 18 27: 1, 3, 9, 27

36. What is the greatest common factor of 18 and 27? ***9***

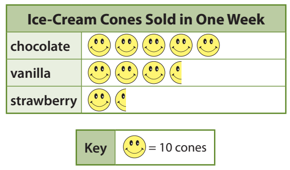
37. What factor is common to 15, 18, and 27? ***3***

38. Round 322,399 and 15,986 to the nearest ten thousand. Estimate the sum and the difference.
320,000; 20,000; 340,000; 300,000

39. Label the number as *prime* or *composite*: 7, 15, 21, 29, 33, 41.
prime: 7, 29, 41; composite: 15, 21, 33

40. Write the value of the expression if $n = 50$.
$4{,}149 - n$ ***4,099*** $17(n)$ ***850*** $1{,}750 + n$ ***1,800*** $40 \times (n + 3)$ ***2,120***

Use the data from the pictograph to find the answer.



41. How many cones of each flavor were sold this week?
chocolate: 50, vanilla: 35, strawberry: 15

42. How many more chocolate cones were sold than strawberry cones? ***35 more chocolate***

43. If this graph remains the same for 4 weeks, how many cones of each flavor will be sold?
chocolate: 4 × 50 = 200
vanilla: 4 × 35 = 140
strawberry: 4 × 15 = 60

J Explain the difference between least common multiple (LCM) and greatest common factor (GCF) using 10 and 15.
The least common multiple is found by listing multiples of each number until a common multiple is found. The greatest common factor is found by listing all of the factors of each number and choosing the greatest one.

LCM: 1, 2, 5, 10
LCM of 10 and 15 is 30.

GCF: 1, 3, 5, 15
GCF of 10 and 15 is 5.

Complete DAILY REVIEW b on page 407.

Lesson 13 33

Apply the Distributive Property of Multiplication over Addition to multiply by multiples of 10

1. Write $2 \times 27 =$ __ for display.

➤ **How can you use mental math to find this product?** ***Elicit that you can multiply each part of the expanded form of the 2-digit factor (27) by 2 and add the partial products.***

2. Write $(2)(20 + 7) =$ __ below $2 \times 27 =$ __. Remind the students of the following: (1) parentheses can be used to indicate multiplication; and (2) the Distributive Property of Multiplication over Addition allows you to separate 1 factor into parts (addends), multiply each part (addend) by the other factor, and add the partial products.

➤ **Guide the students in completing the solution.** ***$(2 \times 20) + (2 \times 7) = 40 + 14 = 54$***

3. Guide the students to the conclusion that the Associative Property of Multiplication is used when only multiplication is used to solve an equation, and the Distributive Property of Multiplication over Addition is used when both multiplication and addition are used to solve a multiplication equation.

4. Choose students to demonstrate applying the Distributive Property to 2×27, using other addends. ***Possible answers: $(2)(17 + 10) = (2 \times 17) + (2 \times 10) = 34 + 20 = 54$; $(2)(15 + 12) = (2 \times 15) + (2 \times 12) = 30 + 24 = 54$***

➤ **Which of these problems do you think is easiest to solve mentally? Why?** ***Answers will vary, but elicit $2 \times (20 + 7)$ because you are multiplying numbers within the basic fact range and multiplying by a multiple of 10.***

Point out that the other addends representing 27 are not within the students' memorized basic fact range, making the multiplication more difficult. Writing one factor in its expanded form limits the multiplying to basic facts and multiples of 10.

5. Direct the students to use the Distributive Property to solve these equations, writing the second factor in expanded form.

$7 \times 43 =$ ***$7 \times (40 + 3) = (7 \times 40) + (7 \times 3) = 280 + 21 = 301$***

$20 \times 56 =$ ***$20 \times (50 + 6) = (20 \times 50) + (20 \times 6) = 1{,}000 + 120 = 1{,}120$***

$25 \times 43 =$ ***$25 \times (40 + 3) = (25 \times 40) + (25 \times 3) = 1{,}000 + 75 = 1{,}075$***

Identify the applied property

Write these equations for display. Choose students to identify the property used and to explain their answers.

$73 + 92 = 92 + 73$ ***Commutative Property of Addition***

$6 + (8 + 20) = (6 + 8) + 20$ ***Associative Property of Multiplication***

$12 \times 30 = 30 \times 12$ ***Commutative Property of Multiplication***

$5 \times (2 \times 10) = (5 \times 2) \times 10$ ***Associative Property of Multiplication***

$3 \times 24 = 3 \times (20 + 4) = (3 \times 20) + (3 \times 4)$ ***Distributive Property of Multiplication over Addition***

Student Text pp. 32–33

Lesson 14

Student Text pp. 34–35
Daily Review p. 407c

Objectives
- Develop an understanding of exponents
- Develop an understanding of squares
- Write numbers in expanded form with multiplication using exponents (powers of 10)

Teacher Materials
- Place Value Kit
- Powers of 10, page IA12 (CD)

Student Materials
- A sheet of graph paper

Teach for Understanding

Develop an understanding of exponents

1. Write $7 + 7 + 7 + 7 + 7 + 7 + 7$ for display.
   ➤ **How many times is 7 repeated as an addend in this addition expression?** ***7 times*** **What multiplication fact can you write for this expression? Why?** ***7×7; there are 7 sets of 7.*** Write 7×7 below the addition expression.
2. Explain that just as multiplication is a shortened way to show repeated addition, *exponent form* is a shortened way to show *repeated multiplication*.
   ➤ **How many times is 7 repeated as a factor in this multiplication expression?** ***2 times***
   Write 7^2 below 7×7. Explain that the factor being repeated (7) is the *base*. Write *base* beside the 7.
   Point to the superscript 2. Explain that the smaller number written to the upper right of the base is called an *exponent*. The exponent indicates the number of times the base is repeated as a factor. Write *exponent* beside the superscript 2.
   Explain that exponents are read using ordinal number words (i.e., second, third, fourth, and so on). Point to each number as you explain that 7^2 is read *seven to the second power*.
3. Write $3 \times 3 \times 3 \times 3 =$ __ for display. Guide the students in multiplying the factors left to right: $3 \times 3 = 9$, $9 \times 3 = 27$, $27 \times 3 = 81$. Write the product.
   ➤ **How can you write this equation using an exponent?** ***Elicit $3^4 = 81$.*** Write $3^4 = 81$ below the equation.
   Point out that another way to find the product is to apply the Associative Property to group the factors. Demonstrate inserting the parentheses: $(3 \times 3) \times (3 \times 3)$.
   ➤ **Now what multiplication fact can you write for the equation?** ***$9 \times 9 = 81$*** **exponent form?** ***$9^2 = 81$***
4. Follow a similar procedure for these equations. Point out that each repeated multiplication expression is the *factored form* of the number written with an exponent.

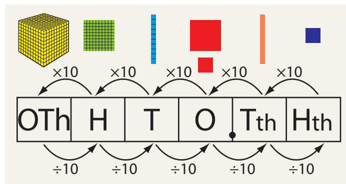
$2 \times 2 \times 2 =$ ***8; $2^3 = 8$***	$5 \times 5 \times 5 \times 5 =$ ***625; $5^4 = 625$***
$8 \times 8 =$ ***64; $8^2 = 64$***	$2 \times 2 \times 2 \times 2 \times 2 =$ ***32; $2^5 = 32$***
$4 \times 4 \times 4 =$ ***64; $4^3 = 64$***	

Develop an understanding of squares

1. Distribute the graph paper. Direct the students to draw an array to represent 7×7 (7 rows of 7 units). Then instruct each student to write several other facts with a repeating factor and to draw an array for each fact. Select students to show their arrays and to explain which fact each array represents.
   ➤ **What do you notice about arrays when the 2 factors are the same number?** ***A square is formed.***
2. Direct the students to write each fact in exponent form. Point out that when a square is formed, the base may vary, but the exponent is always 2. Explain that because a square array is formed, 7 to the second power (7^2) can also be read *seven squared*.
3. Choose students to read aloud the 2 ways that the exponent forms representing their arrays can be read.
4. Guide the students in writing the values for 1^2 through 12^2: $1^2 =$ ***1***; $2^2 =$ ***4***; $3^2 =$ ***9***; $4^2 =$ ***16***; $5^2 =$ ***25***; $6^2 =$ ***36***; $7^2 =$ ***49***; $8^2 =$ ***64***; $9^2 =$ ***81***; $10^2 =$ ***100***; $11^2 =$ ***121***; $12^2 =$ ***144***.

Write the expanded form of a number using exponents

1. Draw for display a place value chart for One Thousands through Hundredths. Display a corresponding Place Value Kit piece above each place; allow enough space to draw the arrows and write $\times$ 10 and $\div$ 10 during the activity. (***Note:*** Above the Ones place, display a small red one below a large red one. You may choose to have a student demonstrate the renaming in each step.)
   ➤ **How many hundredths are needed to make 1 tenth?** ***10***
   Draw an arrow above the chart from the Hundredths place to the Tenths place; label it $\times$ 10.



2. Follow a similar procedure for each place as you move left on the chart.
   ➤ **What do you notice about the value of the place that is just to the left of any place in our base ten place value system?** ***The value is 10 times greater than the value of the place to its right.***
3. Point out that the value of the place that is 2 places to the left of any place is "$\times$ 10 $\times$ 10" greater. Remind the students that 10×10 can be written 10^2 and read *ten to the second power* or *ten squared*.
   ➤ **What is the value of 10^2? How do you know?** ***100; $10 \times 10 = 100$***
   ➤ **What do you notice about the value of the place that is 2 places to the left of any place in our base ten place value system?** ***The value is 100 times greater than the value of the place that is 2 places to its right.***
   ➤ **What do you think is the value of the place that is 3 places to the left of any place?** ***The value is 1,000 times greater than the place that is 3 places to its right.*** Elicit $10 \times 10 \times 10 = 10^3$; it can be read *ten to the third power* and has a value of 1,000.
4. Point to the One Thousands place on the chart.
   ➤ **How many hundreds can 1 one thousand be renamed as?** ***10***
   ➤ **What part of 1 thousand is 1 hundred? How do you know?** ***Elicit $\frac{1}{10}$ because 1 thousand divided into 10 equal parts is 1 hundred.***
   Draw an arrow below the chart from the One Thousands place to the Hundreds place; label it $\div$ 10.
5. Follow a similar procedure for each place as you move right on the chart.
   ➤ **What do you notice about the value of the place that is just to the right of any place in our base ten place value system?** ***The value is $\frac{1}{10}$ of the value of the place to its left.***

Exponents

base
exponent
powers of 10
squared number

Multiplication is a short way to write a repeated addition equation. When a factor is repeated in a multiplication equation, it can be written in exponent form.

$7 + 7 + 7 + 7 + 7 + 7 + 7 = 7 \times 7$ $\quad 7 \times 7 = 7^2$

The **base** tells what number is repeated as a factor.
The **exponent** tells the number of times the base is repeated as a factor.

Standard Form	Factored Form	Exponent Form
1,000,000	$10 \times 10 \times 10 \times 10 \times 10 \times 10$	10^6
100,000	$10 \times 10 \times 10 \times 10 \times 10$	10^5
10,000	$10 \times 10 \times 10 \times 10$	10^4
1,000	$10 \times 10 \times 10$	10^3
100	10×10	10^2
10	10	10^1
1	1	10^0
$\frac{1}{10}$	$\frac{1}{10}$	$\frac{1}{10^1}$
$\frac{1}{100}$	$\frac{1}{10 \times 10}$	$\frac{1}{10^2}$

When 10 is the base, the exponent is the same as the number of zeros in the standard form.

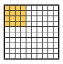
Exponents can be used to express the **powers of 10** in the expanded form of a number.

$546.32 = (5 \times 100) + (4 \times 10) + (6 \times 1) + (3 \times \frac{1}{10}) + (2 \times \frac{1}{100}) =$
$(5 \times 10^2) + (4 \times 10^1) + (6 \times 10^0) + (3 \times \frac{1}{10^1}) + (2 \times \frac{1}{10^2})$

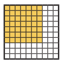
Numbers written in exponent form can be factored to find the standard form.

Exponent Form	Word Form	Factored Form	Standard Form
2^5	two to the fifth power	$2 \times 2 \times 2 \times 2 \times 2$	32
3^7	three to the seventh power	$3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3$	2,187
9^4	nine to the fourth power	$9 \times 9 \times 9 \times 9$	6,561
4^2	four to the second power, or four squared	4×4	16

When a number has an exponent of 2, it is called a **squared number**. An array created for a squared number always forms a square.



$4^2 = 4 \times 4$



$7^2 = 7 \times 7$

Exercises

Write the expression in exponent form.

1. $5 \times 5 \times 5$ *5^3*
2. $9 \times 9 \times 9 \times 9 \times 9$ *9^5*
3. $3 \times 3 \times 3 \times 3$ *3^4*
4. 4×4 *4^2*
5. $8 \times 8 \times 8 \times 8$ *8^4*
6. $1 \times 1 \times 1$ *1^3*
7. $6 \times 6 \times 6$ *6^3*
8. $2 \times 2 \times 2 \times 2 \times 2 \times 2$ *2^6*
9. 7 *7^1*

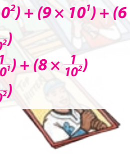
Write the number in factored form.
Use a calculator to solve and write in standard form.

10. 4^5 *1,024*
11. 8^0 *1*
12. 2^4 *16*
13. 7^4 *2,401*
14. 3^2 *9*
15. 9^3 *729*
16. 5^6 *15,625*
17. 1^{10} *1*
18. 6^6 *46,656*
19. 8^5 *32,768*

Write the number in expanded form with multiplication using exponents.

20. 3,862
21. 496
22. 27,296
23. 7.84
24. 12.18
25. 3.76

20. $(3 \times 10^3) + (8 \times 10^2) + (6 \times 10^1) + (2 \times 10^0)$
21. $(4 \times 10^2) + (9 \times 10^1) + (6 \times 10^0)$
22. $(2 \times 10^4) + (7 \times 10^3) + (2 \times 10^2) + (9 \times 10^1) + (6 \times 10^0)$
23. $(7 \times 10^0) + (8 \times \frac{1}{10^1}) + (4 \times \frac{1}{10^2})$
24. $(1 \times 10^1) + (2 \times 10^0) + (1 \times \frac{1}{10^1}) + (8 \times \frac{1}{10^2})$
25. $(3 \times 10^0) + (7 \times \frac{1}{10^1}) + (6 \times \frac{1}{10^2})$



Write the number in standard form.

26. $(6 \times 10^3) + (7 \times 10^2) + (8 \times 10^1)$ *6,780*
27. $(5 \times 10^0) + (6 \times \frac{1}{10^1}) + (2 \times \frac{1}{10^2})$ *5.62*
28. $(8 \times 10^5) + (6 \times 10^4) + (2 \times 10^3) + (1 \times 10^2) + (7 \times 10^0)$ *862,107*
29. $(4 \times 10^6) + (3 \times 10^5) + (1 \times 10^3) + (9 \times 10^2)$ *4,301,900*

Complete the table.
Write the factored form and the standard form of the squared numbers.

30.

	1^2	2^2	3^2	4^2	5^2	6^2	7^2	8^2	9^2	10^2	11^2	12^2
Factored form	*1 × 1*	*2 × 2*	*3 × 3*	*4 × 4*	*5 × 5*	*6 × 6*	*7 × 7*	*8 × 8*	*9 × 9*	*10 × 10*	*11 × 11*	*12 × 12*
Standard form	*1*	*4*	*9*	*16*	*25*	*36*	*49*	*64*	*81*	*100*	*121*	*144*

Solve.

31. Maria read 30 pages of her book each day on Monday and Tuesday. She read 50 pages each day on Thursday and Saturday. How many pages did she read?
$(2 \times 30) + (2 \times 50) = 60 + 100 = 160$ pages
32. Mark wrote the number of baseball cards he has as $10^2 - 14$. How many cards does he have?
$10^2 - 14 = (10 \times 10) - 14 = 100 - 14 =$ 86 cards
33. Martin bought 3 chocolate candies and 2 lollipops for each of his 4 younger sisters. How many pieces of candy did he buy?
$4 \times (3 + 2) = 4 \times 5 = 20$ pieces of candy
34. Monica participated in a walk-a-thon to raise money for her school. She received pledges of \$20 from 10 sponsors. How much money did she raise? *10 × \$20 = \$200*

Practice & Application

35. Write an equation using multiplication for $21 + 25 + 21 + 25 = 92$. *$(2 \times 21) + (2 \times 25) = 92$ or $2 \times (21 + 25) = 92$*
36. What is the product of 40 and 600? *24,000*
37. Use the Distributive Property to solve 38×50.
38. Write the products from *least* to *greatest*.

8^2	2×8	2^3	7×1
7	*8*	*16*	*64*

39. Round to the greatest place to estimate the answer.

$78{,}950 - 8{,}817$	$6{,}432 + 21{,}790$	$0.417 + 0.308$
71,000	*26,000*	*0.7*

40. Write the expanded form and word form for 269.097.

J The presidential election takes place every 4 years. In 2008 the 44th president was elected. Use the term *multiple* to explain why 2018 is not an election year. *2018 is not a multiple of 4.*

37. $(30 + 8) \times 50 = (30 \times 50) + (8 \times 50) = 1{,}500 + 400 = 1{,}900$

40. $269.097 = 200 + 60 + 9 + 0.09 + 0.007$; two hundred sixty-nine and ninety-seven thousandths

Complete DAILY REVIEW C on page 407.

➤ **What part of 1 hundred is 1 one? How do you know?** *$\frac{1}{100}$; 1 hundred divided into 100 equal parts is 1 one.*

➤ **What part of 1 one is 1 hundredth? How do you know?** *$\frac{1}{100}$; 1 one divided into 100 equal parts is 1 hundredth.*

➤ **What do you notice about the value of the place that is 2 places to the right of any place?** *The value is $\frac{1}{100}$ of the value of the place that is 2 places to its left.*

6. Point out that the value of the place that is 2 places to the right of any place is "÷ 10 ÷ 10." Explain that when you divide a unit by 10 you have $\frac{1}{10}$ of the original unit, which can be written $\frac{1}{10^1}$ (one tenth to the first power). When you divide the new unit by 10, you have $\frac{1}{100}$ of the original unit ($\frac{1}{10}$ of $\frac{1}{10}$), which can be written $\frac{1}{10^2}$.

➤ **What do you think is the value of the place that is 3 places to the right of any place?** *The value is $\frac{1}{1{,}000}$ of the value of the place that is 3 places to its left.* Elicit $\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = \frac{1}{10^3}$; it has a value of $\frac{1}{1{,}000}$.

7. Display the Powers of 10 page and review the values written in Standard Form and in Factored Form for each place. Point out that numbers such as 10,000; 1,000; and 100 are *powers of 10*; they can be written using an exponent.

8. Direct attention to the values written in Exponent Form.

➤ **What pattern do you notice between the values written in Exponent Form and in Standard Form?** *Elicit that when 10 is the base in the exponent form, the standard form is the digit 1 followed by the number of zeros indicated by the exponent.*

➤ **What is the value of 10^5?** *100,000* **$\frac{1}{10^5}$?** *$\frac{1}{100{,}000}$* **10^6?** *1,000,000* **$\frac{1}{10^6}$?** *$\frac{1}{1{,}000{,}000}$*

➤ **How would you write one hundred million using 10 as the base and an exponent?** *10^8* **one hundred millionth?** *$\frac{1}{10^8}$*
Point out that any number to the first power is equal to the value of the base (e.g., $10^1 = 10$) and that any number to the zero power is equal to 1 (e.g., $10^0 = 1$).

9. Guide the students in writing these and other numbers in expanded form with multiplication, first using powers of 10 and then using exponents.

324,678,009 *$(3 \times 100{,}000{,}000) + (2 \times 10{,}000{,}000) + (4 \times 1{,}000{,}000) + (6 \times 100{,}000) + (7 \times 10{,}000) + (8 \times 1{,}000) + (9 \times 1)$; $(3 \times \frac{1}{10^8}) + (2 \times \frac{1}{10^7}) + (4 \times \frac{1}{10^6}) + (6 \times \frac{1}{10^5}) + (7 \times \frac{1}{10^4}) + (8 \times \frac{1}{10^3}) + (9 \times \frac{1}{10^0})$*

5.12 *$(5 \times 1) + (1 \times \frac{1}{10}) + (2 \times \frac{1}{100})$; $(5 \times \frac{1}{10^0}) + (1 \times \frac{1}{10^1}) + (2 \times \frac{1}{10^2})0$*

Student Text pp. 34–35

(*Note*: *Assessment* available on Teacher's Toolkit CD.)

Lesson 15 | **Student Text** pp. 36–37 | **Daily Review** p. 408d

Objectives

- Multiply a whole number by a 1- or 2-digit multiplier
- Apply the Distributive Property of Multiplication over Addition
- Estimate the product by rounding to the place of greatest value and by using front-end estimation
- Solve a multiplication word problem

Teacher Materials

- Place Value Kit

Teach for Understanding

Multiply by a 1-digit multiplier

1. Write $4 \times 307 = \_$ in vertical form and instruct the students to write it on paper, aligning the digits in the Ones places of the factors. Remind the students that the multiplier (4) tells the number of sets and the multiplicand (307) tells the number in each set.
   - ➤ **Using the Distributive Property, what equation can you write to solve this problem?** *Elicit $(4 \times 300) + (4 \times 7) = 1200 + 28 = 1{,}228$.* Write the equation and the solution for display; continue to display the solution.
2. Choose a student to use pieces from your Place Value Kit to picture 4×307. *4 sets of 3 hundreds and 7 ones*
3. Demonstrate multiplying the ones (combine the 4 sets of 7 ones [28 ones] and rename them as 2 tens and 8 ones) as you guide the students in multiplying the 7 in the Ones place of the multiplicand by the multiplier 4 for a total of 28 ones; write 8 in the Ones place of the product and write 2 above the Tens place of the multiplicand. (***Note:*** Instruct the students to write the answers in the problem as you write them for display.)
4. Explain that since there are no tens in the multiplicand to multiply, you add the 2 renamed tens to 0 tens ([4×0 tens] + 2 tens). Write the 2 in the Tens place of the product.
5. Demonstrate combining the 4 sets of 3 hundreds (12 hundreds) and renaming them as 1 thousand and 2 hundreds as you guide the students in multiplying the 3 hundreds by 4 in the problem. Point out that since there are no thousands to multiply, you can write 12 hundreds in the product and insert a comma to separate the Thousands period from the Ones period.
   - ➤ **What do you notice about the 12 hundreds in the product?** *Elicit that the 12 hundreds rename as 1 one thousand and 2 hundreds; another name for 12 hundreds is 1 thousand, 2 hundred.*
   - ➤ **What does 4×307 equal?** *1,228*
   - ➤ **How could you estimate the product of 4×307?** *Elicit that you could round 307 to 300 and multiply 4×300 for an estimate of 1,200.*
6. Point out that estimating is similar to completing only the first step of the Distributive Property (4×300), except that when you estimate, you round to the place of greatest value before multiplying.

   Remind the students that an estimate is not an exact answer; it can be very close to or far from the actual answer. Point out that the estimate of 1,200 is very close to the exact product 1,228; you only need to add 28 (4×7) to get the exact product.
7. Write $6 \times 4{,}492 = \_$ and $6 \times 4{,}508 = \_$ horizontally and elicit the estimated products. *24,000 and 30,000*
8. Direct the students to find the exact products. Remind them that when multiplying by a single-digit multiplier, the number of digits in the multiplicand does not change the multiplication process. Give guidance as needed. *26,952 and 27,048*
9. Guide the students in comparing the exact products to the estimated products. Explain that when you multiply a multiplicand in the thousands by a 1-digit multiplier (ones $\times$ thousands), the difference between the estimate and the exact answer can be thousands. Point out that 4,492 rounded down by 492 creates an underestimate of about 3,000 when multiplied by 6 (6×500) and 4,508 rounded up by 492 creates an overestimate of about 3,000 when multiplied by 6 (6×500).
10. Follow a similar procedure for these equations.

    $7 \times 9{,}786 = \_$ *68,502 (70,000); 9,786 rounded up by 214 creates an overestimate of about 1,400 (7×200)*

    $8 \times 25{,}176 = \_$ *201,408 (240,000); 25,176 rounded up by 4,824 creates an overestimate of about 40,000 ($8 \times 5{,}000$)*

    $9 \times 104{,}000 = \_$ *936,000 (900,000); 104,000 rounded down by 4,000 creates an underestimate of 36,000 ($9 \times 4{,}000$)*
   - ➤ **How do you think you can easily find the exact product of $9 \times 104{,}000$?** *Elicit that since the multiplicand rounds to 100,000, adding the product of $9 \times 4{,}000$ to the estimate (900,000) results in the exact answer (936,000).*
11. Explain that you can also use front-end estimation.
   - ➤ **Why would you use front-end estimation rather than rounding to the greatest place?** *to find a more accurate estimate*
   - ➤ **How do you think you would use front-end estimation to estimate a product?** *Elicit that you multiply the greatest 2 places of the multiplicand by the 1-digit multiplier.*
12. Direct attention to the three problems in step 10. Point out that you can complete the first 2 steps of the Distributive Property when using front-end estimation. Guide the students in finding the front-end estimate for each problem and comparing it to the rounded estimate.

    $7 \times 9{,}786 =$ *67,900 (63,000 + 4,900)*

    $8 \times 25{,}176 =$ *200,000 (160, 000 + 40,000)*

    $9 \times 104{,}000 =$ *900,000; because the value of the second greatest place is zero, the 2 estimates are the same.*

Multiply by a 2-digit multiplier

> An egg carton holds 12 eggs. Each case holds 15 egg cartons. How many eggs are in each case? *180 eggs*

- ➤ **What equation is needed to solve this word problem? How do you know?** *$15 \times 12 = \_$; there are 15 sets of 12 eggs in each case.* Write the equation for display.
- ➤ **How do you think you can estimate the product?** *Elicit that you round each factor to the place of greatest value and multiply the rounded factors.*
- ➤ **What is the estimated product? How do you know?** *200; $20 \times 10 = 200$* Write the estimate.
- ➤ **How can you use the Distributive Property to rewrite 15×12?** *You can separate 1 factor into addends and multiply each addend by the other factor.*

When multiplying by a one-digit factor, multiply each place in the **multiplicand** by the **multiplier**.

An estimated product can be found by **rounding** the multiplicand to the greatest place. Multiply the rounded number by the one-digit multiplier. To find a more accurate estimate, use **front-end estimation** and multiply the two greatest places by the one-digit multiplier.

multiplicand
multiplier
estimate by rounding
front-end estimation
Distributive Property
partial products

James knows that there are 5,280 feet in one mile. He wants to find out how many feet long the Fort Peck Dam in Montana is. The dam is about 4 miles long.
4 × 5,280 = ___ feet

Round to the greatest place
4 × 5,000 = 20,000

Front-end estimation
4 × 5,200 = 20,800

The short form of multiplication combines the steps of the **Distributive Property**.

Distributive Property	Short Form
4 × 5,280 = 4 × (5,000 + 200 + 80) = (4 × 5,000) + (4 × 200) + (4 × 80) = 20,000 + 800 + 320 = 21,120	1 3 5,280 × 4 21,120

Multiply the **ones** by 4.
Multiply the **tens** by 4.
Rename 30 of the 32 tens as 3 hundreds.
Multiply the **hundreds** by 4.
Add the renamed 3 hundreds.
Rename 10 of the 11 hundreds as 1 thousand.
Multiply the **thousands** by 4.
Add the renamed 1 thousand.

Exercises

Round to estimate the product. Solve.

1. 78 × 6 *480; 468*
2. 295 × 4 *1,200; 1,180*
3. 529 × 8 *4,000; 4,232*
4. 2,759 × 3 *9,000; 8,277*

Use front-end estimation to find a more accurate estimate.

5. 7 × 2,440 *16,800*
6. 5 × 3,012 *15,000*
7. 9 × 1,799 *15,300*
8. 3 × 8,423 *25,200*

Write the product.

9. 74 × 5 *370*
10. 7,009 × 9 *63,081*
11. 68,691 × 7 *480,837*
12. 4,160 × 3 *12,480*
13. 9 × 38 *342*
14. 4 × 648 *2,592*
15. 5 × 1,093 *5,465*
16. 4 × 8 × 6 *192*
17. 3 × 29 *87*
18. 6 × 953 *5,718*
19. 8 × 1,249 *9,992*
20. (2 × 25) × 5 *250*
21. 7 × 120 *840*
22. 2 × 263 *526*
23. 7^3 *343*
24. 6 × 3 × 7 *126*

Solve.

25. The family's camping destination will be reached in three days if they travel 317 miles each day. How many miles from home will they travel? *3 × 317 = 951 miles*

When multiplying by a two-digit factor, multiply each place in the **multiplicand** by each place of the **multiplier**.

Estimate the product by **rounding** both factors to the greatest place and multiplying.

James used his knowledge of 5,280 feet = 1 mile to find out how many feet are in the 24 miles between his house and his grandmother's house. **24 × 5,280 = ___ feet**

Estimate
20 × 5,000 = 100,000

Solve by using the Distributive Property to find the **partial products**.

24 × 5,280 =
(20 + 4) × 5,280 =
(20 × 5,280) + (4 × 5,280) =
105,600 + 21,120 = 126,720

20 × 5,280 =
20 × (5,000 + 200 + 80) =
(20 × 5,000) + (20 × 200) + (20 × 80) =
100,000 + 4,000 + 1,600 = 105,600

4 × 5,280 =
4 × (5,000 + 200 + 80) =
(4 × 5,000) + (4 × 200) + (4 × 80) =
20,000 + 800 + 320 = 21,120

Solve by using the short form to find the partial products.

```
   1 3
   5,280
 ×    24
  21,120 (4 × 5,280)
+105,600 (20 × 5,280)
 126,720
```

- Find the first partial product by multiplying 4 times 5,280.
- Find the second partial product by multiplying 20 times 5,280. Remember that the multiplier (2) is really a multiple of 10 (20). Write a zero in the Ones place of the second partial product as a placeholder.
- Add the partial products.

Exercises

Round both factors to the greatest place to estimate the product. Solve.

26. 78 × 34 *2,400; 2,652*
27. 42 × 69 *2,800; 2,898*
28. 289 × 51 *15,000; 14,739*
29. 4,962 × 56 *300,000; 277,872*
30. 68 × 729 *49,000; 49,572*
31. 77 × 75 *6,400; 5,775*
32. 62,713 × 34 *1,800,000; 2,132,242*

Use the Associative Property and/or the Commutative Property to solve. Show your grouping.

33. 25 × 75 × 4 *(4 × 25) × 75 = 100 × 75 = 7,500*
34. 3 × 60 × 55 *(3 × 60) × 55 = 180 × 55 = 9,900*
35. 85 × 14 × 8 *(8 × 14) × 85 = 112 × 85 = 9,520*

Use 7 × 473 for problems 36–38.

36. Round to estimate the product. *3,500*
37. Use the Distributive Property to find the product. *3,311*
38. Is the estimated product greater than or less than the product? Explain why. *greater than*

Follow the directions.

39. Write a multiplication equation for the picture.

3 × 2 = 6

J Explain how you can use the Distributive Property to mentally solve 3 × 2,326.

Complete DAILY REVIEW d on page 408.

Elicit the following equations and write them for display. *(10 + 5) × 12 = (10 × 12) + (5 × 12) and 15 × (10 + 2) = (15 × 10) + (15 × 2)*

1. Write 15 × 12 and 12 × 15 vertically for display. Remind the students that the Commutative Property states that the order of factors will not affect the product.
   Explain that the bottom factor in a vertical problem is the multiplier. When you multiply by a multi-digit multiplier, multiply the multiplicand by each digit of the multiplier, beginning with the place of least value (the Ones place in this problem).
2. Choose a student to multiply 5 × 12, showing the renaming. *60* Remind the students that aligning the digits and crossing out any renamed digits as they are added will help them to solve the problem correctly.
   Write (5 × 12) beside 60 as shown below. Explain that 60 is a partial product; it is the product of 1 part of the problem and represents only part of the final product.

```
   1                  1
   12                 15
 × 15               × 12
   60 (5 × 12)        30 (2 × 15)
  120 (10 × 12)      150 (10 × 15)
  180                180
```

3. Remind the students that there is a partial product for each digit in a multiplier.
   ➤ **When you multiply by a multiple of 10, what digit do you write in the Ones place of the partial product?** *0*
   Select a student to write a zero in the Ones place of the second partial product and then multiply 1 (ten) × 12. *120* Write (10 × 12) beside the partial product.
4. Choose a student to add the partial products to find the final product (total). *180* Point out that the overestimate of 200 is reasonable because one factor was rounded up slightly more than the other factor was rounded down.
5. Follow a similar procedure to multiply 12 × 15. Remind the students that they can use the Distributive Property to separate either factor to get the final product: (10 + 5) × 12 or (10 + 2) × 15.
6. Guide the students in writing, estimating, and solving a multiplication problem for 40 rows of 39 seats.
   ➤ **Since there is a 0 in the Ones place of the multiplier, do you need to multiply the multiplicand by the ones? Why?** *No; the partial product is 0 (Zero Property of Multiplication) and does not affect the final product (Identity Property of Addition).*
   Remind the students that they need to write a zero in the Ones place of the product before they multiply by the 4 tens in the multiplier.

```
   39
 × 40
 1,560 seats
```

7. Guide the students in writing, estimating, and solving multiplication problems for 96 buses with 45 students on each bus and 61 rows of 78 seats.

```
     45                     78
   × 96                   × 61
    270 (6 × 45)            78 (1 × 78)
 + 4050 (90 × 45)       + 4680 (60 × 78)
   4320 students          4,758 seats
```

Student Text pp. 36–37

Lesson 16 **Student Text** pp. 38–39
Daily Review p. 408e

Objectives

- Multiply a decimal by a 1- or 2-digit multiplier
- Estimate the product by rounding to the place of greatest value
- Apply the Distributive Property of Multiplication over Addition
- Solve decimal word problems, including money problems
- Solve a multi-step word problem
- Multiply a decimal by a power of 10

Teacher Materials

- Money Kit
- 5 Student Money Kits
- Place Value Kit

Teach for Understanding

Multiply a decimal by a 1-digit multiplier

Sylvia wants to purchase a headband for 2 of her friends and herself. The headbands cost \$4.26 each. What is the total cost of the headbands? ***\$12.78***

➤ **What equation can you write to find the total cost of the headbands?** ***$3 \times \$4.26 = c$*** Write $3 \times \$4.26 = c$ horizontally and vertically. Point out that the variable *c* represents the cost.

➤ **About how much will the headbands cost? Why?** ***\$12.00; $3 \times \$4.00 = \$12.00$***

➤ **Do you think \$12.00 is enough for Sylvia to purchase the headbands? Why?** ***No; elicit that \$12.00 is an underestimate of about \$0.90 because \$4.26 was rounded down by about \$0.30, and $3 \times \$0.30 = \$0.90$.***

➤ **How could Sylvia adjust her estimate to be sure she has enough money to purchase the headbands?** ***Elicit that she could round \$4.26 up because each headband costs more than \$4.00.*** (***Note:*** You may choose to explore various ways to round \$4.26 up to the nearest dollar, dime, quarter, and/or half-dollar.)

1. Choose a student to show $3 \times \$4.26$ using dollars, dimes, and pennies from your Money Kit. ***3 sets of 4 dollars, 2 dimes, and 6 pennies***
2. Select one student to demonstrate the multiplication by combining the sets of like coins, beginning with the pennies (hundredths), and renaming when necessary; choose a second student to simultaneously demonstrate each step in the problem. ***12 dollars, 7 dimes, and 8 pennies; 1278***

   ➤ **What is needed to show that the product is an amount of money?** ***a dollar sign and a decimal point*** Choose a student to write the dollar sign and the decimal point. ***\$12.78*** Elicit that the decimal point separates the dollars (ones) from the cents (hundredths) and the dollar sign labels the product as money.

   Point out that when you multiply by a whole number, there are multiple identical sets of the same units (pennies, dimes, and dollars). Sometimes the units are renamed as larger units, but they are never renamed as smaller units; therefore, the product will be greater than the number being multiplied (the multiplicand).
3. Follow a similar procedure with Place Value Kit pieces for the following word problems. Explain that when you multiply a decimal by a whole number, the product will have the same decimal fraction unit as the multiplicand; tenths multiplied by a whole number results in a product with tenths, and hundredths multiplied by a whole number results in a product with hundredths.

A granola bar weighs 0.87 ounces. How much do 6 granola bars weigh? ***5.22 oz***

$6 \times 0.87 = w$; 6×0.90 oz $= 5.40$ oz; since 0.87 was rounded up by 0.03 and $6 \times 0.03 = 0.18$, there is an overestimate of 0.18; 6 sets of 8 tenths and 7 hundredths; $6 \times 0.87 = 5.22$ oz.
(***Note:*** 0.87 was rounded to the nearest tenth because the Ones place has no value.)

Dad has 4 boards that are 68.75 cm long. When he lays them end to end, what is the combined length of the boards? ***275 cm***

$4 \times 68.75 = b$; 4×70 cm $= 280$ cm; since 68.75 was rounded up by 1.25 and $4 \times 1.25 = 5.00$, there is an overestimate of 5.00; 4 sets of 6 tens, 8 ones, 7 tenths, and 5 hundredths; $4 \times 68.75 = 275$ cm.
(***Note:*** Since the tens and the tenths in the Place Value Kit do not show their proportional difference, you may want to use the Distributive Property to show the repeated sets of each place value: $4 \times 68.75 = 4 \times (60 + 8 + 0.7 + 0.05) = (4 \times 60) + (4 \times 8) + (4 \times 0.7) + (4 \times 0.05) = 240 + 32 + 2.8 + 0.20 = 275$. Then choose a student to solve the vertical problem.)

Multiply a decimal by a 2-digit multiplier

Miss Gable bought 23 cupcakes for \$1.29 each. What was the total cost of the cupcakes? ***\$29.67***

1. Elicit the equation for the word problem and demonstrate solving it. Point out that the process for multiplying a decimal by a whole number is similar to multiplying whole numbers; multiply each place of the multiplicand by each place in the multiplier to find the partial products and add the partial products. Remind the students that when you multiply a decimal with hundredths (sets of hundredths), you will have more hundredths. Write the dollar sign and the decimal point.

$23 \times \$1.29 = c$

$$\begin{array}{r} \$1.29 \\ \times\ \ \ 23 \\ \hline 387\ (3 \times 129) \\ +\ 2580\ (20 \times 129) \\ \hline \$29.67 \end{array}$$

Miss Gable found decorative pencils for \$0.17 each. If she buys 3 pencils for each of her 10 students, what is the total cost of the pencils? ***\$5.10***

➤ **What equation can you write to find the total cost of the pencils?** ***Accept any combination of the factors: $10 \times 3 \times \$0.17$.*** Write $10 \times 3 \times \$0.17$ horizontally for display.

➤ **What does the Commutative Property tell you?** ***The order of the factors does not affect the product.*** **the Associative Property?** ***The grouping of the factors does not affect the product.***

2. Point out that repeated sets of \$0.17 are found by multiplying. Any equation using the factors 10, 3, and \$0.17 can be used to solve the problem, but the best equation pictures the problem as it is described in the word problem.

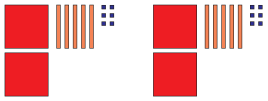
Multiply Decimals by a Whole Number

The process of multiplying a decimal by a whole number is similar to the process of multiplying whole numbers. After multiplying all places, the decimal point must be placed in the correct location in the product. The number of decimal places in the product is determined by the number of places in the decimal factor.

Estimate the product by rounding the decimal to the nearest whole number or to the greatest place. Choose whichever place allows you to find the estimate using mental math. The estimate will help you with the placement of the decimal point in the product.

2 × 2.56

2 sets of 2.56



Estimate

$3 \times 2 = 6$

$2.56 \times 2 = 5.12$

4 × $21.25

4 sets of $21.25

Estimate

$21 × 4 = $84 or $20 × 4 = $80

$21.25 × 4 = $85.00

Exercises

Estimate the product. Solve. *Estimates may vary depending on estimating strategy used.*

1. 3.018 × 5 *15; 15.090*
2. 16.7 × 8 *160; 133.6*
3. 4.009 × 3 *12; 12.027*
4. 32.4 × 10 *300; 324.0 or 324*
5. 1.98 × 13 *26; 25.74*
6. 20.05 × 7 *140; 140.35*
7. $25.05 × 12 *$360 or $300; $300.60*
8. $42.16 × 2 *$84 or $80; $84.32*
9. 3 × 0.09 *0.3; 0.27*
10. 11 × $4.99 *$55; $54.89*
11. 10 × $2.50 *$30; $25.00*
12. 6 × 1.013 *6; 6.078*

Solve. *Equations may vary.*

13. Mrs. Mowrey found shirts on sale for $24.95. She bought one for her husband and one for each of her two sons. How much did the shirts cost? *3 × $24.95 = $74.85*
14. Mrs. Mowrey also bought a suit for her husband for $189.99. How much more did she spend on the suit than on the three shirts? *$189.99 – $74.85 = $115.14*
15. Caryn baked 256 cookies for a church fellowship. Three plates with 14 cookies each were left over after the fellowship. How many cookies were eaten? *256 – (3 × 14) = 256 – 42 = 214 cookies*
16. Mr. Phelps bought four steaks to cook out on the grill for the family. Two of the steaks weighed 1.14 pounds each, and the other two steaks weighed 1.26 pounds each. How many pounds of steak did Mr. Phelps buy in all? *(2 × 1.14 lb) + (2 × 1.26 lb) = 2.28 + 2.52 = 4.80 lb*
17. Mr. Phelps also brought three bags of vegetables to cook on the grill. If each bag weighed 10.7 ounces, what was the total weight of the vegetables purchased? *3 × 10.7 oz = 32.1 oz*

38 Chapter 2

Powers of 10

When multiplying a decimal by a power of 10, move the decimal point one place to the right for each zero in the factor (10, 100, 1,000). Annex zeros as needed.

$10^1 \times 23.75 = 10 \times 23.75 = 237.5$ — Think 23.75

$10^2 \times 0.956 = 100 \times 0.956 = 95.6$ — Think 0.956

$10^3 \times 368.1 = 1{,}000 \times 368.1 = 368{,}100$ — Think 368.100

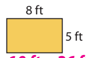
Exercises

Use mental math to solve. Write only the answer.

18. 10 × 14.9 *149*
19. 100 × 1.42 *142*
20. 100 × 6.39 *639*
21. $10^1 \times 87.5$ *875*
22. 10 × 0.012 *0.12*
23. 1000 × 3.78 *3,780*
24. 1000 × 2.86 *2,860*
25. $10^2 \times 97.25$ *9,725*

Practice & Application

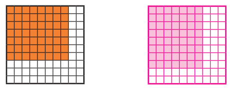
26. What is 90,000 more than 1 million? *1,090,000*
27. Write an equation using multiplication to find the perimeter of the quadrilateral. *(2 × 8 ft) + (2 × 5 ft) = 16 ft + 10 ft = 26 ft*

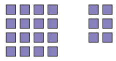


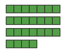
28. Choose the expression that has the same value as 6 × 9.
    $3^2 \times (2 \times 3)$ $2 \times (3 \times 3)$ $3 \times (2 \times 2)$
29. Write the expanded form for 187.396 and 18.7396. *187.396 = 100 + 80 + 7 + 0.3 + 0.09 + 0.006; 18.7396 = 10 + 8 + 0.7 + 0.03 + 0.009 + 0.0006*
30. Write two addition equations and two subtraction equations using the numbers 100, 65, and 35. *65 + 35 = 100; 35 + 65 = 100; 100 – 35 = 65; 100 – 65 = 35*
31. What product does 4^5 represent? *4 × 4 × 4 × 4 × 4 = 1,024*
32. List the first twelve nonzero multiples of 8. *8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88, 96*
33. Write three facts for each of the composite numbers 24 and 12. *Answers may vary. 24: 1 × 24; 2 × 12; 3 × 8; 4 × 6 12: 1 × 12; 2 × 6; 3 × 4*

Use illustrations *a*, *b*, and *c* for problems 34–36.

34. Write an equation for the array in illustration *a*. Use the Commutative Property to write another equation. Illustrate the new equation. *7 × 8 = 56; 8 × 7 = 56*
35. The expression (4 × 4) + (3 × 2) could be written for illustration *b*. Write this expression using exponents and solve. *$4^2 + 6 = 22$*
36. Which expression is true of illustration *c*: (3 × 7) + 4 or 3 × (7 + 4)? Explain your answer. *(3 × 7) + 4; there are 3 rows of 7 plus 1 row of 4.*

a. 

b. 

c. 

Complete DAILY REVIEW on page 408.

Lesson 16 39

3. Guide a discussion about how the problem could be solved. Elicit the following explanations and guide the students in writing the equations, using parentheses to identify what they would do first. *Find the total number of pencils needed for all 10 students (10 sets of 3) and then multiply the number of pencils needed times the cost of each pencil (10 × 3) × $0.17; find the cost of 3 pencils and multiply that amount by the number of students: 10 × (3 × $0.17).* Point out that the first factor in each equation tells the number of sets. (***Note:*** You may choose to accept variations in the equations, noting the Commutative or Associative Properties.)
4. Guide the students in solving the first step of (10 × 3) × $0.17. *30* Demonstrate writing 30 × $0.17 vertically and guide the students in solving it; use the following procedure.
   - ➤ **Do you need to multiply by the ones? Why?** *No; the partial product would be 0 and a 0 partial product will not affect the final product.*
5. Remind the students that they need to write a 0 in the product (below the 0 in 30) before they multiply by the 3 tens. *0510*
   - ➤ **What is needed in the product?** *Elicit a decimal point to separate the whole numbers (dollars) from the decimal fraction (cents, part of a dollar) and a dollar sign to label the answer as money.* Write the dollar sign and the decimal point. Elicit that the location of the decimal point shows hundredths and that the 0 in the Tens place is not necessary; erase it. *$5.10*
   - ➤ **How can you estimate this problem?** *Elicit that you can round both factors: 30 sets (pencils) × 20 cents (hundredths) = 600 cents (hundredths).*
   - ➤ **What is the value of 600 cents?** *$6.00* **Is the answer $5.10 reasonable?** *yes* Point out that estimating is helpful in checking the placement of the decimal point in the product.
6. Follow a similar procedure for 10 × (3 × $0.17). *3 × $0.17 = $0.51; 10 × $0.51 = $5.10*

Multiply a decimal by a power of 10

- ➤ **What do you notice about the decimal point in $0.51 when you multiplied it by 10? Why?** *The decimal point moved one place to the right; elicit that each place was multiplied by 10, making the value of each digit 10 times greater and renaming it to the next greater place.*

1. Choose a student to use the student Money Kits to show 10 × $0.51 *10 sets of 5 dimes and 1 penny* and another student to use your Place Value Kit to show 10 × 0.51 *10 sets of 5 tenths and 1 hundredth*. Instruct each student to combine his sets, renaming as needed. Point out the 10-times increase in each unit and its being renamed to the next greater unit; e.g., 10 × 1 penny (1 hundredth) = 10 pennies (10 hundredths) renamed as 1 dime (1 tenth). *$5.10; 5 and 1 tenth = 5.1*
2. Guide the students in multiplying these decimals by powers of 10. Point out that you move the decimal point one place to the right for each zero in the power of 10, annexing zeros as needed, similar to multiplying a whole number by a power of 10.

10 × 0.1 = *1*	10 × 0.5 = *5*
3.42 × 10 = *34.2*	$526.19 × 10 = *$5,261.90*
100 × 0.1 = *10.0*	100 × 0.006 = *0.6*
$10^2 \times 87.4$ = *8,740*	$10^3 \times 9.6$ = *9,600*

Student Text pp. 38–39

Lesson 17	Student Text pp. 40–41
	Daily Review p. 409f

Objectives

- Multiply by a 3-digit multiplier
- Estimate the product by rounding to the place of greatest value
- Solve a money multiplication problem
- Determine the number of partial products in a multiplication problem
- Apply strategies to multiply mentally

Teacher Materials

- Christian Worldview Shaping, pages 4–6 (CD)

Teach for Understanding

Multiply by a 3-digit multiplier

Timmons Hardware Shop sells a special type of nail for \$1.95 each. Mr. Jones needs 112 of these nails for a construction project. What is the total cost of the nails? ***\$218.40***

➤ **What equation is needed to solve this word problem? How do you know?** ***112 × \$1.95 = c; 112 nails are needed at a cost of \$1.95 each.***

1. Write the equation for display.

➤ **How could you estimate the total product?** ***Round both factors to the greatest place and multiply.***

➤ **What is the estimated cost? Why?** ***\$200.00; 100 × \$2.00 = \$200.00*** Write the estimate for display. Point out that since you rounded down (12) more than you rounded up (0.05), the estimate is an underestimate.

2. Write 112 × \$1.95 vertically. Explain that the process for multiplying by a 3-digit multiplier is similar to multiplying by a 2-digit multiplier, except that you will have an additional partial product because you have the Hundreds place to multiply by.
   Guide the students in solving the equation. Write the factors of each partial product. Point out that you annex 2 zeros in the partial product before multiplying each place in the multiplicand by the digit in the Hundreds place of the multiplier.

\$1.95	
× 112	
390	*(2 × 195)*
1950	*(10 × 195)*
+ 19500	*(100 × 195)*
\$218.40	*(100 + 10 + 2) × \$1.95*

3. Guide the students in using the Distributive Property to write one equation showing the factors for each of the 3 partial products of 112 × \$1.95. ***(100 × \$1.95) + (10 × \$1.95) + (2 × \$1.95) = \$218.40***
4. Write 203 × 3,567 in vertical form.

➤ **How many partial products will you need to write when solving this problem? How do you know?** ***2; (200 × 3,567) + (3 × 3,567); elicit that you do not need to write the partial product for the 0 in the Tens place of the multiplier because the partial product is 0 (Zero Property of Multiplication) and does not affect the final product (Identity Property of Addition).***

5. Guide the students in solving the problem; follow a procedure similar to the one used for the previous word problem. Explain that when you omit a partial product, you need to annex the correct number of zeros in the next partial product.
   200 × 4,000 = 800,000; overestimate

3,567	
× 203	*2 partial products*
10701	*(3 × 3,567)*
+ 713400	*(200 × 3,567)*
724,101	*(200 × 3,567) + (3 × 3,567) = 724,101*

6. Repeat the procedure for 375 × 427.
   400 × 400 = 160,000; underestimate

427	
× 375	*3 partial products*
2135	*(5 × 427)*
29890	*(70 × 427)*
+ 128100	*(300 × 427)*
160,125	*(300 × 427) + (70 × 427) + (5 × 427) = 160,125*

7. **Christian Worldview Shaping (CD)**

Apply strategies to multiply mentally

1. Write 7 × 24 for display. Remind the students that they can use their knowledge of the Distributive Property to multiply mentally.

➤ **How could you use the Distributive Property to solve this problem without writing anything on paper?** ***Elicit that you could think of the partial products and add them together: 7 × 20 = 140; 7 × 4 = 28; 140 + 28 = 168.***

2. Explain that this strategy is sometimes referred to as *front-end multiplication*. Direct the students to use this strategy to find the products of these problems and to write only the answers on paper.
   - 6 × 53 ***6 × 50 = 300; 6 × 3 = 18; 300 + 18 = 318***
   - 4 × 34 ***4 × 30 = 120; 4 × 4 = 16; 120 + 16 = 136***
   - 5 × 48 ***5 × 40 = 200; 5 × 8 = 40; 200 + 40 = 240***
   - 7 × 17 ***7 × 10 = 70; 7 × 7 = 49; 70 + 49 = 119***
   - 3 × 86 ***3 × 80 = 240; 3 × 6 = 18; 240 + 18 = 258***
   - 8 × 64 ***8 × 60 = 480; 8 × 4 = 32; 480 + 32 = 512***
3. Write 9 × 13 for display.

➤ **How could you use your knowledge of multiplying by a power of 10 to solve this problem without writing anything on paper?** ***Elicit that you could think of the product of 10 × 13 (130) and subtract 13 from it because 10 × 13 is one more set of 13 than 9 × 13.***

➤ **What is the product of 9 × 13?** ***117***
Write *10 × 13 = 130 and 130 − 13 = 117, so 9 × 13 = 117* in a think cloud below the equation.

4. Follow a similar procedure for 9 × 27. ***10 × 27 = 270 and 270 − 27 = 243, so 9 × 27 = 243***
5. Write 11 × 18 for display.

➤ **How could you solve this problem, using your knowledge of multiplying by a power of 10, without writing anything on paper?** ***Elicit that you could think of the product of 10 × 18 (180) and add 18 to it because 11 × 18 is one more set of 18 than 10 × 18.***

➤ **What is the product of 11 × 18?** ***198***

3-Digit Multipliers

The number of digits in the multiplier typically matches the number of **partial products** in the solution. However, because the Commutative Property allows the order of the factors to be changed, if a factor has a zero in it, you can use that factor as the multiplier and eliminate finding a partial product.

partial products
compensation

The Tennessee Valley Authority was created in 1933 to help build dams and provide electricity. A small town in the valley had a population of 203 people in the early 1930s. After a dam was built, the town's population increased 125 times. What was the new population?
125 × 203 = ___ people

203	
× 125	
1015	(5 × 203)
4060	(20 × 203)
+ 20300	(100 × 203)
25,375	(125 × 203)

125	
× 203	
375	(3 × 125)
+ 25000	(200 × 125)
25,375	(203 × 125)

Exercises

Round both factors to the greatest place to estimate the product. Solve.

1. 498 × 318 ***150,000; 158,364***
2. 639 × 548 ***300,000; 350,172***
3. 786 × 308 ***240,000; 242,088***
4. 8,645 × 729 ***6,300,000; 6,302,205***
5. 42 × 784 ***32,000; 32,928***
6. 749 × 254 ***210,000; 190,246***
7. 629 × 36 ***24,000; 22,644***
8. 72 × 9,015 ***630,000; 649,080***

Solve.

9. 77 × 281 ***21,637***
10. 3 × $19.28 ***$57.84***
11. 14 × $3.86 ***$54.04***
12. 5 × 6.793 ***33.965***
13. 117 × 428 ***50,076***
14. 15 × 27 ***405***
15. 21 × 150 ***3,150***
16. 11 × 9.8 ***107.8***

Solve. ***Equations may vary.***

17. The Wagner family traveled from Utah to Pennsylvania to visit the Johnstown Flood National Memorial. They drove the following distances each day: Monday, 632 miles; Tuesday, 685 miles; Wednesday, 713 miles; Thursday, 610 miles; and Friday, 805 miles. How many miles did they travel in all? ***632 + 685 + 713 + 610 + 805 = 3,445 miles***
18. If they traveled the same route on the way home, what is the total distance for the round trip? ***2 × 3,445 = 6,890 miles***
19. Before leaving Utah, the Wagners' car odometer read 38,597 miles. What was the odometer reading when the family arrived in Johnstown? ***38,597 + 3,445 = 42,042***
20. Mr. Wagner's car gets approximately 26 miles per gallon. He paid an average of $2.87 per gallon. What was the cost of gasoline for the entire trip if he used 265 gallons? ***265 × $2.87 = $760.55***

J Sam estimated the product for 29 × 573 as 18,000. Would the actual product be *less than* or *greater than* the estimate? Explain your answer. ***less than the actual product because both numbers are rounded up to estimate***

The Unger House, Johnstown Flood National Memorial

Colonel Elias J. Unger built this house in the mid-1880s. The house and property were added to the Johnstown Flood National Memorial in 1981 to help preserve the historic scene.

Mental Multiplication Strategies

Front-End Multiplication (Distributive Property)
Use front-end multiplication (Distributive Property) to multiply by a one-digit factor.

5 × 27 =
(5 × 20) + (5 × 7) =
100 + 35 = 135

4 × 268 =
(4 × 200) + (4 × 60) + (4 × 8) =
800 + 240 + 32 = 1,072

Compensation
Use compensation when one of the factors is 9 or 11. You can multiply by 10 and **add** or **subtract** a set of the other factor.

9 × 46 =
10 × 46 = 460
460 − 46 = 414
Subtract a set of 46.
9 × 46 = 414

11 × 54 =
10 × 54 = 540
540 + 54 = 594
Add a set of 54.
11 × 54 = 594

Right-to-Left Cross Multiplication
Use right-to-left cross multiplication when multiplying two-digit factors.

28 × 32 =

1. Multiply the ones.
   8 × 2 = 16
   Write 6 in the Ones place.
2. Cross-multiply.
   8 × 3 tens = 24 tens
   2 tens × 2 = 4 tens
   24 tens + 4 tens + 1 ten = 29 tens
   Write 9 in the Tens place.
3. Multiply the tens.
   2 tens × 3 tens = 6 hundreds
   6 hundreds + 2 hundreds = 8 hundreds
   Write 8 in the Hundreds place.
   The product is 896.

Remember the 1 ten.
1
 32
× 28
 6

Remember 2 hundreds.
2 ~~1~~
 32
× 28
 96

2 ~~1~~
 32
× 28
896

Exercises

Use front-end multiplication to solve. Write only the answer.

21. 5 × 36 ***180***
22. 7 × 62 ***434***
23. 6 × 48 ***288***
24. 8 × 24 ***192***

Use compensation to solve. Write only the answer.

25. 9 × 78 ***702***
26. 9 × 34 ***306***
27. 9 × 88 ***792***
28. 9 × 64 ***576***
29. 11 × 72 ***792***
30. 11 × 16 ***176***
31. 11 × 58 ***638***
32. 11 × 37 ***407***

Use right-to-left cross multiplication to solve. Write only the answer.

33. 23 × 12 ***276***
34. 84 × 56 ***4,704***
35. 35 × 32 ***1,120***
36. 63 × 48 ***3,024***

Solve.

37. Kristie participated in 3 marathons of 26.2 miles each. What was the total number of miles she ran? ***3 × 26.2 = 78.6 miles***
38. The school purchased 11 cases of paper at a cost of $15.75 per case. What was the total cost of the paper? ***11 × $15.75 = $173.25***
39. An airplane made 14 trips of 4,890 miles each this month. How many miles did it fly in all? ***14 × 4,890 = 68,460 miles***

Complete DAILY REVIEW f on page 409.

Write *10 × 18 = 180 and 180 + 18 = 198, so 11 × 18 = 198* in a think cloud below the equation.

6. Write 11 × 43 for display. Choose a student to tell the product and to explain how he determined the answer. ***10 × 43 = 430 and 430 + 43 = 473, so 11 × 43 = 473***

   Explain that this method of mental multiplication is called *compensation*; it is best used when one of the factors is 9 or 11.

7. Write 14 × 12 in vertical form. Explain that there is another strategy for multiplying mentally called *right-to-left cross multiplication*. The title of the strategy gives the steps to follow for finding a product. You begin on the *right* and multiply the ones. Draw an arrow from the 4 to the 2 as shown below (the red A arrow).

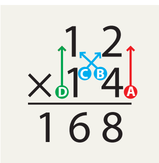
   ➤ **What is 4 × 2 ones?** ***8 ones*** Write 8 in the Ones place of the product.

   Explain that the next step is to *cross-multiply*. Draw the crossed arrows as shown (the blue B and C arrows).

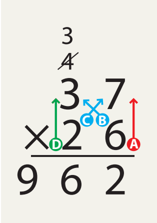
   ➤ **What is 4 × 1 ten and 1 ten × 2?** ***4 tens + 2 tens = 6 tens*** Write 6 in the Tens place of the product.

   ➤ **What do you think is the next step?** ***Elicit that you need to multiply the tens on the left.*** Draw an arrow to show the final step (the green D arrow).

   ➤ **What is 1 ten × 1 ten?** ***1 hundred*** Write 1 in the Hundreds place of the product.



8. Follow a similar procedure for 26 × 37. Point out that this problem involves renaming.



A 6 × 7 = 42
B 6 × 3 = 18
C 2 × 7 = 14
18 + 14 + 4 = 36
D 2 × 3 = 6
6 + 3 = 9

9. Write similar problems for display and direct the students to solve them mentally, writing only the answers on paper.

Student Text pp. 40–41

(***Note***: *Assessment* available on Teacher's Toolkit CD.)

Lesson 18 **Student Text** pp. 42–43
Daily Review p. 409g

Objectives
- Develop an understanding of finding perfect squares
- Develop an understanding of finding the square root of a perfect square
- List the first 20 perfect squares and their square roots
- Use the Pythagorean Theorem to find the measurement of the hypotenuse of a right triangle

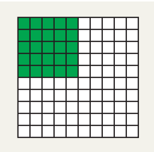
Teacher Materials
- Graph Paper, page IA13 (CD)
- Perfect Squares & Square Roots, page IA14 (CD)

Student Materials
- Graph Paper, page IA13 (CD)
- Perfect Squares & Square Roots, page IA14 (CD)
- A calculator (optional)

Teach for Understanding

Develop an understanding of finding perfect squares

1. Display and distribute the Graph Paper page. Direct the students to color a 5×5 array in the first section as shown below.



➤ **What multiplication expression can you write for this array?** ***5×5***
Write the expression below the grid.
➤ **What is the value of 5×5?** ***25***
Write $= 25$ to complete the equation.
➤ **How can you write $5 \times 5 = 25$ using an exponent?** ***$5^2 = 25$***
Repeat the procedure with $3 \times 3 =$ ***9, $3^2 = 9$*** and $8 \times 8 =$ ***64, $8^2 = 64$***.

2. Underline 25, 9, and 64. Point out that 25, 9, and 64 have something in common. Elicit that each is a product of a number and itself. These products are called *perfect squares*.

Perfect Squares	
$1 \times 1 = 1^2 =$	1
$2 \times 2 = 2^2 =$	4
$3 \times 3 = 3^2 =$	9
$4 \times 4 = 4^2 =$	16
$5 \times 5 = 5^2 =$	25
$6 \times 6 = 6^2 =$	36
$7 \times 7 = 7^2 =$	49
$8 \times 8 = 8^2 =$	64
$9 \times 9 = 9^2 =$	81
$10 \times 10 = 10^2 =$	100
$11 \times 11 = 11^2 =$	121
$12 \times 12 = 12^2 =$	144
$13 \times 13 = 13^2 =$	169
$14 \times 14 = 14^2 =$	196
$15 \times 15 = 15^2 =$	225
$16 \times 16 = 16^2 =$	256
$17 \times 17 = 17^2 =$	289
$18 \times 18 = 18^2 =$	324
$19 \times 19 = 19^2 =$	361
$20 \times 20 = 20^2 =$	400

3. Display and distribute the Perfect Squares and Square Roots page. Guide the students in finding the first 20 perfect squares and in completing the Perfect Squares table. You may choose to let them use a calculator for facts that are not memorized.

Develop an understanding of finding the square root of a perfect square

1. Remind the students about inverse operations with these examples: $3 + 2 = 5$, $5 - 2 = 3$; $3 \times 6 = 18$, $18 \div 6 = 3$.
2. Write $\sqrt{25}$ for display. Explain that this symbol written with a number that is a perfect square indicates that you perform the inverse of finding the perfect square. You find the number that was multiplied by itself (squared) to give the number (product) that is inside the symbol.
➤ **What are the two equal factors that equal 25?** ***5 and 5***
Write $= 5$ after the expression $\sqrt{25}$. Explain that when you "unsquare" a number, you are finding its *square root*. Explain that this equation is read *the square root of 25 equals 5*.
3. Follow a similar procedure to guide the students in determining the square root of each perfect square that was calculated and in writing it in the Square Roots table. You may choose to start in the middle of the chart to discourage students from just writing 1, 2, 3, 4, and so on, as answers without thinking of the number that was multiplied by itself to make the perfect square. Allow the students to refer to the Perfect Squares table to help with facts that are not memorized.

Square Roots
$\sqrt{1} = 1$
$\sqrt{4} = 2$
$\sqrt{9} = 3$
$\sqrt{16} = 4$
$\sqrt{25} = 5$
$\sqrt{36} = 6$
$\sqrt{49} = 7$
$\sqrt{64} = 8$
$\sqrt{81} = 9$
$\sqrt{100} = 10$
$\sqrt{121} = 11$
$\sqrt{144} = 12$
$\sqrt{169} = 13$
$\sqrt{196} = 14$
$\sqrt{225} = 15$
$\sqrt{256} = 16$
$\sqrt{289} = 17$
$\sqrt{324} = 18$
$\sqrt{361} = 19$
$\sqrt{400} = 20$

Squares & Square Roots

A **square** is the product of a number times itself.
The product of a whole number squared is a **perfect square**.

Since $5 \times 5 = 25$, then $5^2 = 25$.
The exponent 2 is used to express a number squared.

$5 \times 5 = 25$

square
perfect square
square root
hypotenuse
Pythagorean theorem

Exercises

Find the square of the number. Write the equation.

1. $2^2 = \underline{4}$; $\underline{2} \times \underline{2} = \underline{4}$
2. $3^2 = \underline{9}$; $\underline{3} \times \underline{3} = \underline{9}$
3. $4^2 = \underline{16}$; $\underline{4} \times \underline{4} = \underline{16}$
4. $9^2 = \underline{81}$; $\underline{9} \times \underline{9} = \underline{81}$
5. $10^2 = \underline{100}$; $\underline{10} \times \underline{10} = \underline{100}$
6. $6^2 = \underline{36}$; $\underline{6} \times \underline{6} = \underline{36}$

A **square root** is one of a number's two equal factors.
$\sqrt{}$ is the **square root sign**.
Read $\sqrt{25} = 5$: "the square root of 25 equals 5."

Finding the square root of a number is the inverse of squaring a number.
Since $5^2 = 25$, then $\sqrt{25} = 5$.

$5 \times 5 = 25$

Exercises

Find the square root of the number by using the array.

7. $\sqrt{36} = \underline{6}$
8. $\sqrt{64} = \underline{8}$
9. $\sqrt{49} = \underline{7}$

Find the square root.

10. $\sqrt{4}$ 2
11. $\sqrt{9}$ 3
12. $\sqrt{81}$ 9

Mom's waffle iron makes square waffles. Each waffle has 16 squares. How many squares are along one side of each waffle? Why? *4 squares; because the waffle is a square and the square root of 16 is 4.*

42 Chapter 2

Complete the perfect squares and the square roots.

13. Since $1^2 = 1 \times 1 = 1$, then $\sqrt{1} =$ __. 1
14. Since $2^2 = 2 \times 2 =$ __, then $\sqrt{4} =$ __. 4; 2
15. Since $3^2 = 3 \times 3 =$ __, then $\sqrt{9} =$ __. 9; 3
16. Since $4^2 = 4 \times 4 =$ __, then $\sqrt{16} =$ __. 16; 4
17. Since $5^2 = 5 \times 5 =$ __, then $\sqrt{25} =$ __. 25; 5
18. Since $6^2 = 6 \times 6 =$ __, then $\sqrt{36} =$ __. 36; 6
19. Since $7^2 = 7 \times 7 =$ __, then $\sqrt{49} =$ __. 49; 7
20. Since $8^2 = 8 \times 8 =$ __, then $\sqrt{64} =$ __. 64; 8
21. Since $9^2 = 9 \times 9 =$ __, then $\sqrt{81} =$ __. 81; 9
22. Since $10^2 = 10 \times 10 =$ __, then $\sqrt{100} =$ __. 100; 10

Pythagorean Theorem

In a right triangle, the three sides are related. The longest side of the triangle (the side opposite the right angle) is called the **hypotenuse**. The square of the hypotenuse is equal to the sum of the squares of the other two sides. This rule is called the **Pythagorean theorem**.

$a^2 + b^2 = c^2$

3 cm, 4 cm

$4^2 + 3^2 = c^2$
$16 + 9 = c^2$
$25 = c^2$
$\sqrt{25} = c$
$5 \text{ cm} = c$

Exercises

Find the length of side c of the triangle. Complete the equation.

23. 6 in., 8 in.

$6^2 + 8^2 = c^2$
__ + __ $= c^2$ 36; 64
__ $= c^2$ 100
$\sqrt{}$ __ $= c$ 100
__ in. $= c$ 10

24. 9 ft, 12 ft

__^{2} + __^{2} $= c^2$ 9; 12
__ + __ $= c^2$ 81; 144
__ $= c^2$ 225
$\sqrt{}$ __ $= c$ 225
__ ft $= c$ 15

Use a calculator to solve.

25. 14^2 196
26. 13^2 169
27. 17^2 289
28. 20^2 400
29. 18^2 324

Complete DAILY REVIEW 9 on page 409.

Lesson 18 43

Use the Pythagorean Theorem to find the measurement of the hypotenuse of a right triangle

Instruct the students to locate the information about the Pythagorean Theorem on Student Text page 43. Guide them in reading the information and using the Pythagorean Theorem to find the measurement of the hypotenuse of the right triangles in problems 23 and 24.

Student Text pp. 42–43

Lesson 19

Student Text pp. 44–45

Chapter Review

Objectives

- Write a multiplication equation for a given picture
- Apply properties of multiplication: Commutative Property, Associative Property, Identity Property, Zero Property, and Distributive Property
- Use mental math to multiply factors that are multiples of 10
- Estimate the product by rounding to the place of greatest value and by using front-end estimation
- Multiply by a 1-, 2-, or 3-digit multiplier
- Identify the GCF and the LCM of a pair of numbers
- Determine the value of an exponent

Teacher Materials

- Pictures of Multiplication, page IA15 (CD)

Preparation

Write these equations for display. (Do not write the answers or the estimates.)

I. $4 \times 30 =$ ***120*** $\quad 70 \times 80 =$ ***5,600***
$2 \times 900 =$ ***1,800*** $\quad 60 \times 500 =$ ***30,000***
$10 \times 27{,}000 =$ ***270,000*** $\quad 300 \times 800 =$ ***240,000***

II. $10 \times 2.7 =$ ***27*** $\quad 10 \times 8.35 =$ ***83.5***
$100 \times 4.6 =$ ***460*** $\quad 100 \times 0.35 =$ ***35***

III.

$35.17	1.3	8.3	71,249	2,891
× 8	× 20	× 25	× 38	× 356
$281.36	***26***	***415***	***569992***	***17346***
($320)	***(20)***	***+ 1660***	***+ 2137470***	***144550***
		207.5	***2,707,462***	***+ 867300***
		(240)	***(2,800,000)***	***1,029,196***
				(1,200,000)

Note

This lesson reviews the concepts presented in Chapter 2 to prepare the students for the Chapter 2 Test. Student Text pages 44–45 provide the students with an excellent study guide.

Check for Understanding

Write a multiplication equation for a given picture

Display the Pictures of Multiplication transparency. Choose students to write multiplication equations for the pictures and to explain the relationship between the picture and the equation.

1. ***3 × 5 = 15***
2. ***2 × 5 = 10***
3. ***6 × 9 = n; n = 54***
4. ***3n = 21; n = 7***
5. ***8 × 8 = 64***
6. ***10 × 14 = 140, 10 × (10 + 4) = 140, or (10 × 10) + (10 × 4) = 140***

Apply properties of multiplication

Direct the students to write on paper the answers for these statements.

- ➤ **Apply the Commutative Property of Multiplication to 8 × 4 = 32.** ***4 × 8 = 32***
- ➤ **Explain the Zero Property of Multiplication.** ***When 0 is a factor, the product is 0.***
- ➤ **Apply the Associative Property of Multiplication to the factors 2, 3, and 5.** ***possible answer: 2 × (3 × 5) = (2 × 3) × 5 = 30***
- ➤ **Apply the Distributive Property of Multiplication over Addition to 3 × 26 and solve the equation mentally.** ***3 × (20 + 6) = (3 × 20) + (3 × 6) = 60 + 18 = 78***
- ➤ **Write a multiplication fact that shows the Identity Property of Multiplication.** ***Accept any multiplication fact with a factor of 1.***

Use mental math to multiply factors that are multiples of 10

1. Direct attention to the section I equations written for display. Elicit that you can mentally find the product of factors that are multiples of 10 by multiplying the basic fact, or the non-zero factors, and then annexing the total number of zeros in the factors. Choose students to write the products for display.
2. Remind the students that when you multiply a number by 10, the value of every digit in that number becomes 10 times greater and renames to the next greater place, requiring you to write (annex) a zero in the Ones place of the product to show the renaming; e.g., $10 \times 32 = 320$. Point out that the same is true for powers of 10 ($100 \times 32 = 3{,}200$; $1{,}000 \times 32 = 32{,}000$; and so on).
3. Direct attention to the section II equations.
   - ➤ **How is multiplying a decimal by 10 similar to multiplying a whole number by 10?** ***Elicit that when multiplying a decimal by 10, the value of each digit in the decimal becomes 10 times greater and renames to the next greater place, requiring you to move the decimal point one place to the right in the product, just as you do when you annex a zero while multiplying a whole number by 10.***
4. Use the following questions as you guide the students in mentally solving the equations.
   - ➤ **How can you check to see if you moved the decimal point in the correct direction?** ***Elicit that when multiplying any number by a whole number, the product will be greater than the number being multiplied.***
   - ➤ **When multiplying by a power of 10, what must you do when the decimal being multiplied (multiplicand) has fewer digits to the right of the decimal point than the number of zeros in the multiplier? Why?** ***Elicit that you must annex a zero in the product for each place without a digit to show the renaming of each digit to the next greater place.*** Elicit that when there is no decimal fraction, a decimal point is not written to the right of the Ones place in a whole number.

Estimate and solve multiplication problems

> The Montgomery family spent 14 days visiting historical sites in America. They traveled an average of 234 miles each day. About how many miles did they travel in all?
> ***10 × 200 = 2,000 miles***

- ➤ **How can you find about how many miles the Montgomery family traveled?** ***estimate***

1. Direct the students to estimate the miles traveled by rounding to the greatest place. ***2,000 miles***
   - ➤ **Did the Montgomery family actually travel more or less than 2,000 miles? Why?** ***More; elicit that 2,000 miles is an underestimate because both factors were rounded down.***
2. Choose a student to demonstrate solving for the exact number of miles traveled. ***14 × 234 = 3,276 miles*** Point out that the answer is greater than the underestimate of 2,000 miles. Elicit that when both factors are rounded up, the result is an overestimate; when 1 factor is rounded up more than the

CHAPTER 2 REVIEW

Write a multiplication equation for the picture. Solve.

1. 60 | 12 | 12 | 12 | 12 | 12 — *$5 \times 12 = 60$*

2. *$8 \times 9 = 72$*

3. 1 Dozen | 1 Dozen | 1 Dozen | 1 Dozen — *$4 \times 12 = 48$*

Use mental math to solve. Write only the answer.

4. 5×50 *250*
5. 60×40 *2,400*
6. $8{,}000 \times 5$ *40,000*
7. 900×200 *180,000*
8. 700×60 *42,000*
9. 800×9 *7,200*
10. 300×400 *120,000*
11. $40 \times 2{,}000$ *80,000*

Use front-end estimation to find a more accurate estimate. Solve.

12. $5{,}684 \times 3$ *16,800; 17,052*
13. $28{,}167 \times 5$ *140,000; 140,835*
14. $\$45.72 \times 4$ *\$180.00; \$182.88*
15. $\$17.61 \times 8$ *\$136.00; \$140.88*

Round both factors to the greatest place to estimate the product. Solve.

16. 165×56 *12,000; 9,240*
17. 756×31 *24,000; 23,436*
18. 953×72 *70,000; 68,616*
19. $1{,}795 \times 308$ *600,000; 552,860*

Use the multiplication properties to write the missing number.

20. $\underline{0} \times 81 = 0$
21. $46 \times 19 = 19 \times \underline{46}$
22. $6 \times (14 \times 10) = (6 \times \underline{10}) \times 14$
23. $9 \times 6 = (9 \times 3) + (9 \times \underline{3})$
24. $17 \times (30 + \underline{4}) = 17 \times 34$
25. $1 \times 307 = \underline{307}$

Use the Associative Property and/or the Commutative Property to solve. Show your grouping.

26. $5 \times 7 \times 8$ *$(5 \times 8) \times 7 = 40 \times 7 = 280$*
27. $4 \times 17 \times 25$ *$(4 \times 25) \times 17 = 100 \times 17 = 1{,}700$*
28. $21 \times 3 \times 11$ *$(21 \times 3) \times 11 = 63 \times 11 = 693$*

Use the Distributive Property to solve.

29. 49×80 *3,920*
30. 60×107 *6,420*
31. 219×30 *6,570*

Label the number as prime or composite. Write two facts for each composite number.

32. 17 *prime*
33. 49 *composite* *1×49* *7×7*
34. 55 *composite* *1×55* *5×11*
35. 30 *composite* *1×30* *2×15* *3×10* *5×6*
36. 23 *prime*

44 Chapter 2

Complete the table.

37.

Standard Form	Factored Form	Exponent Form
216	*$6 \times 6 \times 6$*	6^3
625	$5 \times 5 \times 5 \times 5$	*5^4*
1,024	$4 \times 4 \times 4 \times 4 \times 4$	*4^5*
1,000,000	*$10 \times 10 \times 10 \times 10 \times 10 \times 10$*	*10^6*
1,000	$10 \times 10 \times 10$	*10^3*
100,000	*$10 \times 10 \times 10 \times 10 \times 10$*	10^5

Write the number in standard form.

38. $(6 \times 10{,}000) + (3 \times 1{,}000) + (9 \times 10) + (4 \times 1)$ *63,094*
39. $(6 \times 10^3) + (3 \times 10^2) + (9 \times 10^1) + (4 \times 10^0)$ *6,394*
40. $(6 \times 10^2) + (3 \times 10^0) + (9 \times \frac{1}{10^1}) + (4 \times \frac{1}{10^2})$ *603.94*

Solve.

41. List the factors of 18 and 24 in order. *18: 1, 2, 3, 6, 9, 18; 24: 1, 2, 3, 4, 6, 8, 12, 24*
42. What is the greatest common factor of 18 and 24? *6*
43. List the multiples of 18 and 24 to find a common multiple. *18: 18, 36, 54, 72; 24: 24, 48, 72* *A common multiple of 18 and 24 is 72.*

Solve. *Equations may vary.*

44. Mrs. Davidson bought a 10-pound Thanksgiving turkey that was priced at \$0.89 per pound. How much did the turkey cost? *$10 \times \$0.89 = \$8.90$*
45. Grandma gave \$4.50 to each of her eight grandchildren. How much money did she give in all? *$8 \times \$4.50 = \$36.00$*
46. Coach Rees totaled the basketball players' scores for the season. Daniel and Aaron each scored 167 points, and Andrew scored 112 points. What was the total number of points the three boys scored? *$(2 \times 167) + 112 = 334 + 112 = 446$ points*
47. Mr. and Mrs. Calvin have saved \$2,150 each year for 4 years for their trip to the Holy Land. The trip costs \$4,500 per person. How much more money do they need for their trip? *$(2 \times \$4{,}500) - (4 \times \$2{,}150) = \$9{,}000 - \$8{,}600 = \$400$*

Sea of Galilee

Lesson 19 45

other factor is rounded down, the result is an overestimate; and when 1 factor is rounded down more than the other factor is rounded up, the result is an underestimate.

3. Follow a similar procedure for this word problem.

> Mrs. Wilson wants to order 6 books for a ladies Bible study group. Each book costs \$6.35. About how much will 6 books cost? *$6 \times \$6.00 = \$36.00$; underestimate; $6 \times \$6.36 = \$38.16$*

4. Direct attention to the section III problems. Direct each student to estimate the answer by rounding to the place of greatest value, to identify the estimate as an underestimate or an overestimate, and to solve for the exact answer.
5. Direct the students to use front-end estimation to find a more accurate estimate for the first problem in section III. *$8 \times \$35.00 = \$280.00$*

Identify the GCF or the LCM of a pair of numbers

➤ **What is a factor?** *a number multiplied to find a product* **a prime number?** *a number greater than 1 that has only 2 factors, 1 and the number itself* **a composite number?** *a number greater than 1 that has more than 2 factors*

1. Choose students to list for display the factors of 12 and 30 and to circle the common factors. *1, 2, 3, 6*

   12: *1, 2, 3, 4, 6, 12*

   30: *1, 2, 3, 5, 6, 10, 15, 30*

➤ **What is the GCF of 12 and 30?** *6*

➤ **What is a multiple?** *the product of 2 whole numbers*

2. Instruct the students to list the first 6 nonzero multiples of 12 and 30 and to circle the common multiples. *60*

   12: *12, 24, 36, 48, 60, 72*

   30: *30, 60, 90, 120, 150, 180*

➤ **What is the LCM of 12 and 30?** *60*

Remind the students that since 0 is a common multiple of all numbers, it is not considered when determining the LCM.

➤ **What other multiple of 30 in the list is also a multiple of 12? How do you know?** *120; $10 \times 12 = 120$*

Determine the value of an exponent

Remind the students that repeated factors can be written using exponents. Guide the students in finding the value of these exponents and expressions.

$2^4 = 2 \times 2 \times 2 \times 2 = 16$ $\quad$ $5^3 = 5 \times 5 \times 5 = 125$

$4^2 = 4 \times 4 = 16$ $\quad$ $3^2 \times 6 = 3 \times 3 \times 6 = 54$

$4 \times 10^2 = 400$ $\quad$ $8 \times \frac{1}{10^3} = 8 \times \frac{1}{10 \times 10 \times 10} = 8 \times \frac{1}{1{,}000} = \frac{8}{1{,}000}$ or 0.008

Student Text pp. 44–45

Lesson 20

Student Text pp. 46–49

Chapter 2 Test

Cumulative Review

For a list of the skills reviewed in the Cumulative Review, see the Lesson Objectives for Lesson 20 in the Chapter 2 Overview on page 28 of this Teacher's Edition.

Student Materials

- Cumulative Review Answer Sheet, page IA9 (CD)

Use the Cumulative Review on Student Text pages 46–48 to review previously taught concepts and to determine which students would benefit from your reteaching of the concepts. To prepare the students for the format of achievement tests, instruct them to work on a separate sheet of paper, if necessary, and to mark the answers on the Cumulative Review Answer Sheet.

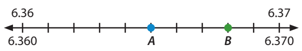
Use the Exploring Ideas on Student Text page 49 (page 47 of this Teacher's Edition) any time after this chapter.

Mark the answer.

11. $(8 \times 10{,}000) + (6 \times 1{,}000) + (4 \times 100) + (4 \times 10) + (5 \times 1)$
A. 806,445
B. 86,445
C. 864.45

12. $(8 \times 100) + (2 \times 10) + (3 \times 1) + (6 \times 0.1) + (4 \times 0.01) + (8 \times 0.001)$
A. 823.648
B. 823.68
C. 8.23

13. seven hundred fifty million, four hundred three thousand, eight hundred twelve
A. 705,403,812
B. 75,403,812
C. 750,403,812



14. Point *A*
A. 6.35
B. 6.365
C. 6.4

15. Point *B*
A. 6.361
B. 6.368
C. 6.45

16.

180		
110	40	*n*

A. $n = 40$
B. $n = 55$
C. $n = 30$

17.

1,500		
n	*n*	*n*

A. $n = 50$
B. $n = 30$
C. $n = 500$

18.

n	
1,700	300

A. $n = 14$
B. $n = 2{,}000$
C. $n = 1{,}400$

19.

275	
33	*n*

A. $n = 91$
B. $n = 9$
C. $n = 242$

20.

n		
9	9	9

A. $n = 27$
B. $n = 3$
C. $n = 36$

CUMULATIVE REVIEW

Test Prep

Mark the property.

1. $583 + 14 = 14 + 583$
A. Commutative
B. Associative
C. Identity

2. $136 + 0 = 136$
A. Commutative
B. Associative
C. Identity

3. $(23 + 41) + 72 = 23 + (41 + 72)$
A. Commutative
B. Associative
C. Identity

4. $15.7 + a = a + 15.7$
A. Commutative
B. Associative
C. Identity

5. $a + (b + c) = (a + b) + c$
A. Commutative
B. Associative
C. Identity

Mark the answer.

6. What is the difference between 7,693 and 9,762?
A. 2,001
B. 2,036
C. 2,069
D. none of the above

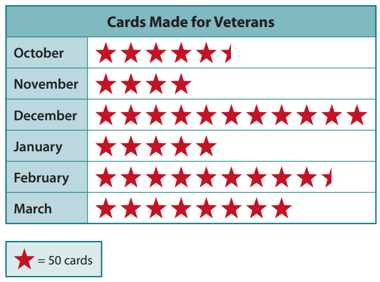
7. What is the sum of 2,683 and 5,937?
A. 8,277
B. 8,620
C. 8,944
D. none of the above

8.
$$\begin{array}{r} 4{,}320 \\ 26{,}393 \\ 17{,}825 \\ +\ 32{,}285 \\ \hline \end{array}$$
A. 79,357
B. 80,004
C. 80,823
D. none of the above

9. A family took $300.00 on vacation. They returned home with $72.50. How much did they spend?
A. $227.50
B. $372.50
C. $237.40
D. none of the above

10. $8.2 - n = 3.9$
A. 43
B. 4.1
C. 4.3
D. none of the above

Use the data from the pictograph to find the answer.



21. What is the difference in the number of cards made in November and January?
A. 100
B. 50
C. 25

22. How many cards were made in February?
A. 575
B. 475
C. 525

23. In December, 350 of the cards were Christmas cards. How many December cards were not for Christmas?
A. 100
B. 200
C. 250

24. In which month were the least number of cards made?
A. January
B. October
C. November

25. How many cards were made from January through March?
A. 2,300
B. 1,150
C. 1,125

EXPLORING IDEAS

High Power Calculations

Remember, an exponent tells how many times the base number is multiplied by itself.

$$\mathbf{10^{12}} = 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1{,}000{,}000{,}000{,}000$$

The number 10 is multiplied by itself 12 times to equal 1 trillion.

Do you know the word *googol*? A googol is a 1 followed by 100 zeros. In exponential form, a googol is "ten to the hundredth power"—10^{100}. The mathematician Edward Kasner, who introduced the term *googol*, credited his nine-year-old nephew Milton Sirotta with naming this number.

It can be helpful to use a calculator when working with large numbers in exponential form. Write the following numbers in standard form. Use a calculator to multiply.

1. 3^7 **2,187**

2. 25^5 **9,765,625**

3. 0.11^3 **0.001331**

4. 0.2^7 **0.0000128**

5. 7^6 **117,649**

6. 15^6 **11,390,625**

7. 2.1^5 **40.84101**

8. 0.14^3 **0.002744**

Multiply to rename each number in standard form. Use a calculator.

9. 3^2 **9**
33^2 **1,089**
333^2 **110,889**
$3{,}333^2$ **11,108,889**

10. 6^2 **36**
66^2 **4,356**
666^2 **443,556**
$6{,}666^2$ **44,435,556**

11. 9^2 **81**
99^2 **9,801**
999^2 **998,001**
$9{,}999^2$ **99,980,001**

Solve.

12. $9 - 2$ **7**
$9^2 - 2^2$ **77**
$59^2 - 52^2$ **777**
$559^2 - 552^2$ **7,777**

13. $8 - 3$ **5**
$8^2 - 3^2$ **55**
$58^2 - 53^2$ **555**
$558^2 - 553^2$ **5,555**