# Whole Number Long Division

## Objectives
To review and practice the U.S. traditional long division algorithm for single-digit divisors; and to extend the algorithm to multidigit divisors.

## Doing the Project

### Recommended Use
During or after Lesson 4-4

### Key Activities
Students review, practice, and extend the U.S. traditional long division algorithm for whole numbers.

### Key Concepts and Skills
- Use long division to divide whole numbers by single-digit and multidigit whole numbers.  
  [Operations and Computation Goal 3]
- Apply multiplication and division facts in the long division algorithm.  
  [Operations and Computation Goal 2]
- Use estimation to carry out the long division algorithm efficiently.  
  [Operations and Computation Goal 6]

### Key Vocabulary
- **dividend** • **divisor** • **quotient** • **remainder**

## Extending the Project

Students create and solve long division puzzles.

### Materials
- Math Journal, pp. 9–12
- Student Reference Book, pp. 24E–24H
- Play money (optional)

### Technology
See the iTLG.
Project 12 Whole Number Long Division

1 Doing the Project

Reviewing Long Division with Single-Digit Divisors

(Math Journal, p. 9)

Have students solve Problem 1 on journal page 9. Tell them they may use paper and pencil, or any manipulatives or tools that they wish, except calculators.

Have volunteers explain their solutions. Expect that students will use several different methods, including partial-quotients division, various informal pencil-and-paper approaches, dealing with manipulatives, and drawing pictures. Some students may also use the U.S. traditional long division algorithm, which was introduced and practiced in fourth-grade projects. See margin.

Review how to solve the problem using the long division algorithm. Illustrate each step with pictures and, if possible, model the steps using play money. Emphasize the connections between the steps in the long division algorithm and the process of sharing money.

NOTE Sharing money is a useful context for teaching and learning long division. The process of sharing bills of various denominations ($100 bills, $10 bills, and $1 bills) and coins (dimes and pennies), starting with the largest denomination and trading for smaller denominations as necessary, is broadly parallel to the steps in the long division algorithm.

1. A local newspaper decides to give bonuses to its delivery workers. The paper gave $2,365 in bonuses, which was shared evenly by 6 workers. How much did each worker get?
   $394, with $1 left over

2. $837 / 3
   Answer: $279

3. $2,257 / 5
   Answer: $451 R$2, or $451.40

4. $8,091 / 9
   Answer: $899

5. 782 / 4
   Answer: $195 R$2, or 195.5

NOTE Although the largest note in circulation today is the $100 bill, in the past, limited numbers of much larger bills have been issued, including $1,000, $10,000, and $100,000 bills. These notes were withdrawn from circulation by President Nixon because they were rarely used and were attractive to counterfeiters.
Step 1:
Write the problem $2,365 / 6$ in the long division format on the board or a transparency.

$6 \overline{)2\,3\,6\,5}$

$2,365$ is to be shared: $2,365$ is the **dividend**.

The money is to be shared by 6 workers:
6 is the **divisor**.

Step 2:
Encourage students to think about sharing actual bills:
2 $[$1,000$]$s, 3 $[$100$]$s, 6 $[$10$]$s, and 5 $[$1$]$s. There are not enough $[$1,000$]$s for 6 equal shares, so trade the 2 $[$1,000$]$s for 20 $[$100$]$s. There were 3 $[$100$]$s already, so there are $20 + 3 = 23$ $[$100$]$s after the trade.

$6 \overline{)2\,3\,6\,5}$

20 $[$100$]$s from the 2 $[$1,000$]$s + 3 $[$100$]$s = 23 $[$100$]$s.

Step 3:
Share the 23 $[$100$]$s. Each worker gets 3 $[$100$]$s; 5 $[$100$]$s are left over.

$6 \overline{)2\,3\,6\,5}$

3 $[$100$]$s each for 6 workers = 18 $[$100$]$s.

5 $[$100$]$s are left.

Step 4:
Trade the 5 $[$100$]$s for 50 $[$10$]$s. There were 6 $[$10$]$s already, so there are $50 + 6 = 56$ $[$10$]$s.

$6 \overline{)2\,3\,6\,5}$


Step 5:

$6 \overline{)2\,3\,6\,5}$


2 $[$10$]$s are left.
Step 6:

Trade the 2 \([\$10]\)s for 20 \([\$1]\)s. There were 5 \([\$1]\)s already, so there are 20 + 5 = 25 \([\$1]\)s.

\[
\begin{array}{c}
3 & 9 \\
-1 & 8 \\
-5 & 4 \\
\hline
2 & 5 \\
\end{array}
\]

20 \([\$1]\)s from the 2 \([\$10]\)s + 5 \([\$1]\)s = 25 \([\$1]\)s.

Step 7:

Share the 25 \([\$1]\)s. Each worker gets 4 \([\$1]\)s; 1 \([\$1]\) is left over.

\[
\begin{array}{c}
3 & 9 & 4 \\
-1 & 8 \\
-5 & 4 \\
\hline
2 & 4 \\
\end{array}
\]

Each worker gets 4 \([\$1]\)s.

24 \([\$1]\)s each for 6 workers = 24 \([\$1]\)s.

1 \([\$1]\) is left.

Step 8:

Each worker gets $394: $394 is the quotient. The $1 that is left over is the remainder. A number model is a good way to show the answer:

\[
\begin{array}{c}
6 & \mid & 2 & 3 & 6 & 5 \\
\hline \\
- & 2 & 3 & 6 & 5 \\
-5 & 6 \\
-5 & 4 \\
\hline \\
-2 & 4 \\
\hline \\
1 \\
\end{array}
\]

$2,365 / 6 \rightarrow $394 R$1

The U.S. traditional long division algorithm is complicated, so consider working one or two more examples with the whole class. Continue to use sharing money as a context and drawing pictures to show actions with money, as needed.

Suggestions:

- $4,967 / 6 = $827 R$5
- $705 / 5 = $141
- $2,048 / 4 = $512
Solving Long Division Problems with One-Digit Divisors
(Math Journal, pp. 9 and 10; Student Reference Book, pp. 24E and 24F)

Have students use long division to solve Problems 2–9 on journal pages 9 and 10. They might find the examples on Student Reference Book, pages 24E and 24F helpful.

Introducing Long Division with Multidigit Divisors
(Math Journal, p. 11)

Have students solve Problem 1 on journal page 11. Circulate and assist.

When most students have finished, discuss students’ solutions. Expect that students will use various methods.

\[
\begin{align*}
27 \div 6714 &= 248 \text{ R}18 \\
- 2700 &= 100 \\
- 2700 &= 100 \\
- 2700 &= 100 \\
- 540 &= 20 \\
- 540 &= 20 \\
- 354 &= 5 \\
- 234 &= 2 \\
- 127 &= 1 \\
\hline
18 &= 248
\end{align*}
\]

Partial quotients Long division

Demonstrate how to solve the problem using the long division algorithm. Illustrate each step on the board or a transparency.

Carrying out the long division algorithm with multidigit divisors can be challenging, particularly for students whose estimation skills are not well-developed. Have students make a table of simple multiples of the divisor to use in deciding how many to share at each step.

\[
\begin{align*}
6714 &= 27 \times 248 \text{ R}18 \\
6714 &= 27 \times 248 \text{ R}18
\end{align*}
\]
Solve: $6,714 / 27$

$6,714$ has only 6 [$1,000$]s, which are not enough to share among 27 teachers. Trade the 6 [$1,000$]s for 60 [$100$]s, which makes 67 [$100$]s in all. Share the 67 [$100$]s among the 27 teachers. Use the table of multiples to help decide how many each teacher should get.

\[
27 \div 6,714 = \]

Each teacher gets 2 [$100$]s.

Trade 6 [$1,000$]s for 60 [$100$]s. There were 7 [$100$]s before, so there are 67 [$100$]s after the trade.

2 [$100$]s each for 27 teachers = 54 [$100$]s.

13 [$100$]s are left.

Trade the 13 [$100$]s for 130 [$10$]s. There was 1 [$10$] already, so there are 131 [$10$]s after the trade. Share the 131 [$10$]s among the 27 teachers.

Each teacher gets 4 [$10$]s.


Each teacher gets 8 [$1$]s.

$6,714 / 27 \rightarrow \$248 \text{ R} \$18$

Each teacher gets \$248. \$18$ are left over.
Discuss what the remainder means in this problem. It's the part of the original $6,714 raised by the carnival that is left over after each of the 27 teachers receives $248. Ask students what they think should be done with the leftover money. Some students may want to continue dividing. The $18 left over could be traded for 180 dimes, shared 27 ways, and so on. The quotient, even carried to pennies, won't come out evenly. There will be 18 pennies left over. However, by continuing the division, a bit more of the carnival proceeds could be distributed. Project 13 will extend the long division algorithm to decimal dividends. Some students might want to attempt to extend the method on their own.

Work more examples as necessary until students understand the procedure.

Suggestions:
- $9,475 / 26 \rightarrow ? \$364 \text{ R}\$11
- $16,248 / 13 \rightarrow ? \$1,249 \text{ R}\$11
- $7,089 / 47 \rightarrow ? \$150 \text{ R}\$39

### Solving Long Division Problems with Multidigit Divisors

*(Math Journal, pp. 11 and 12; Student Reference Book, pp. 24G and 24H)*

Have students use long division to solve Problems 2–9 on journal pages 11 and 12. They may find the examples on *Student Reference Book*, pages 24G and 24H helpful.

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**Student Page**

**Student Resource Book, p. 24G**

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**Long Division With Multidigit Divisors**

- **Step 1:** Start with the thousands.
  - Each share gets 1 thousand.
  - 3 thousand are left.

- **Step 2:** Trade 3 thousands for 30 hundreds. Share the hundreds.
  - Each share gets 3 hundreds.
  - 4 hundreds are left.

- **Step 3:** Trade 4 hundreds for 40 tens. Share the tens.
  - Each share gets 4 tens.
  - 2 tens are left.

**Student Journal, p. 12**

**Math Journal, p. 12**
One of the hardest steps in carrying out the U.S. traditional long division algorithm is accurately estimating the quotient at each step. As traditionally performed, any wrong estimate, either too high or too low, will cause the algorithm to fail—the incorrect estimate must be erased and replaced.

Using a table of easy multiples is one way to address this problem. Another approach is illustrated below.

\[
\begin{array}{c|llll}
7 & 6 & 2 & 2 & 5 \\
\hline
-4 & 2 & 2 & 5 & 6 \\
-1 & 4 & 6 & 5 & 9 \\
-5 & 6 & 9 & 2 & 2 \\
\end{array}
\]

### 2 Extending the Project

#### Long Division Puzzles

(Math Journal, p. 12; Math Masters, p. 415)

Have partners follow the directions at the bottom of Math Journal, page 12. Provide copies of the computation grid (Math Masters, page 415). Ask volunteers to explain how they checked their answers in Step 2. Consider having students make long division puzzles for classroom display.