Lesson 13: Dividing Multi-Digit Numbers Using the Algorithm

Student Outcomes

- Students understand that the standard algorithm of division is simply a tally system arranged in place value columns.

Classwork

Example 1 (3 minutes)

The first example is a review from lesson 12 to start taking a deeper look at the division algorithm.

Example 1

a. Create a model to divide: 1,755 ÷ 27.

*Answers may vary. One possible solution:*

\[
\begin{array}{c|c}
\hline
27 & \ \\
60 & 1620 \\
5 & 135 \\
\hline
\end{array}
\]

b. Use the division algorithm to show 1,755 ÷ 27.

\[
\begin{array}{c|c}
\hline
27 & 65 \\
1755 & -162 \\
135 & -135 \\
0 & \\
\hline
\end{array}
\]

Looking at your division work, where did the numbers 162 and 135 come from?

\[
\begin{array}{c|c}
\hline
27 & 65 \\
1755 & -162 \\
135 & -135 \\
0 & \\
\hline
\end{array}
\]

- The 162 comes from \(27 \times 6\). This is really showing \(27 \times 60\), which is 1,620. The 135 comes from \(27 \times 5\).
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If you had to describe what is happening underneath the division bar in your own words, what would you say? (For struggling students, have them think back to what they did when they used a model.)

- The work under the long division bar shows how I keep track of the parts that I have already divided out. Then I can see what remains to continue the process.

c. Check your work.

\[ 27 \times 65 = 1,755 \]

Example 2 (3 minutes)

Example 2
Find the quotient of \(205,276 \div 38\).

\[
\begin{array}{c}
38 \overline{)205,276} \\
-190 \\
\hline
152 \\
-152 \\
\hline
76 \\
-76 \\
\hline
0
\end{array}
\]

- How can we use estimation to start solving this problem?

  - Answers will vary. I can start by determining how many times 40 will divide into 200 thousands. I know that \(40 \times 5 = 200\). So I will start the division process by placing a 5 over the 5 in 205,276. This 5 represents 5 thousands. So we will show in the long division that \(200\) thousands \(\div 38 = 5\) thousands.

- Why did you divide 40 into 200 instead of 200,000?

  - I thought of this problem as 40 into 200 thousands, so that I could divide 40 into 200 to make the division simpler.

Give students a chance to complete the division. Students should also be creating a model to show the connection between the algorithm and the model.

- Aou divided by 400, what did you do next?

  - I had brought down the seven to complete the next step. However, 38 does not divide into 7 one or more times. This told me to put a 0 in the tens place and bring down the 6 to continue dividing.
Imagine that your friend wrote 542 as the answer. How could you prove to your friends that 542 is not the solution?

- Answers may vary. I could use estimation. I would round the divisor and quotient and multiply them to see if I get an estimate that is close to the dividend $40 \times 500 = 20,000$. The estimate is about 10 times too small. So I can tell that the numbers are in the wrong place. I should have an estimate around 200,000.

Now, let's use the algorithm to work through a division question that involves a much larger number.

**Example 3 (3 minutes)**

Example 3
Find the quotient of $17,216,673 \div 23$.

- When working with a dividend as large as this, what would happen if we tried to solve this question using a model?
  - Answers will vary. The model would be difficult to make because it could have many parts for the different place values.

- It might be difficult to figure out how many times 23 goes in to this whole number. So we can break this into parts. Does 23 go into 1 one or more times? Does 23 go into 17 one or more times? Will 23 divide into 172 one or more times?
  - 23 does not go into 1 or 17 more than one time. However, 23 will go into 172.

- Could we use estimation to help us start the problem?
  - We could think about $175 \div 25$ or $180 \div 20$ (or other possible estimations that are backed by mathematical reasoning).

\[
\begin{array}{c|c}
23 & 7 \\
\hline
17216673 & -161 \\
\hline
11 & \end{array}
\]

Remind students that what we are actually doing is 172 hundred thousands $\div 23 = 7$ hundred thousands.

Each step can be represented using the units.

- Why would we place the 7 over the 2 and not somewhere else? What does the 7 represent?
  - The 7 shows how many times 23 goes into 172, but it really represents how many times 23 goes into 17,200,000. Because the 7 represents 700,000, we place the 7 over the 2 in the hundred thousands place.

- When we subtracted, we got an 11. What does this 11 represent?
  - The 11 shows the difference between 172 and 161, but it actually represents 1,100,000. This is the amount remaining after 23 groups of 700,000 are taken from 17,200,000.
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- After we have completed this first set of steps, where do we go next?
  - We could keep repeating the process until we reach the ones place.

```
          748551
    ---
23 | 17216673
     -161
      ---
       111
        -92
         ---
          196
           -184
             ---
              126
                -115
                 ---
                  117
                    -115
                      ---
                       23
                          -23
                            ---
                             0
```

When discussing the remaining steps you can refer to them as follows:
- 111 ten thousands ÷ 23: 4 ten thousands
- 196 thousands ÷ 23: 8 thousands
- 126 hundreds ÷ 23: 5 hundreds
- 117 tens ÷ 23: 5 tens
- 23 ones ÷ 23 = 1

- How can we determine if the answer is reasonable?
  - We could multiply the quotient with the divisor. \(748,551 \times 23 = 17,216,673\)
  - We could also use an estimate to check our work. \(20,000,000 ÷ 20 = 1,000,000\). Our estimate is slightly larger because we rounded the dividend up.

Exercises 1–6 (20 minutes)
Give students a chance to practice using the division algorithm. Students may not be able to complete all questions in the time given.

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2. \(484,692 \div 78\)

\[
\begin{array}{c|c|c}
\text{78} & \text{484692} & \text{6214} \\
-156 & -468 & \\
-109 & -312 & \\
-78 & -312 & \\
\hline
0 & 0 & \\
\end{array}
\]

a. \(484 \text{ thousands} \div 78: 6 \text{ thousands}\)
\(166 \text{ hundreds} \div 78: 2 \text{ hundreds}\)
\(109 \text{ tens} \div 78: 1 \text{ ten}\)
\(312 \text{ ones} \div 78: 4 \text{ ones}\)

b. \(6,214 \times 78 = 484,692\)

3. \(281,886 \div 33\)

\[
\begin{array}{c|c|c}
\text{33} & \text{281886} & \text{8542} \\
-264 & -8542 & \\
-178 & -138 & \\
-165 & -132 & \\
\hline
-66 & 0 & \\
\end{array}
\]

a. \(281 \text{ thousands} \div 33: 8 \text{ thousands}\)
\(178 \text{ hundreds} \div 33: 5 \text{ hundreds}\)
\(138 \text{ tens} \div 33: 4 \text{ tens}\)
\(66 \text{ ones} \div 33: 2 \text{ ones}\)

b. \(8,542 \times 33 = 281,886\)

4. \(2,295,517 \div 37\)

\[
\begin{array}{c|c|c}
\text{37} & \text{2295517} & \text{62041} \\
-222 & -62041 & \\
-75 & -151 & \\
-74 & -148 & \\
\hline
-37 & 0 & \\
\end{array}
\]

a. \(229 \text{ ten thousands} \div 37: 6 \text{ ten thousands}\)
\(75 \text{ thousands} \div 37: 2 \text{ thousands}\)
\(15 \text{ hundreds} \div 37: 0 \text{ hundreds}\)
\(151 \text{ tens} \div 37: 4 \text{ tens}\)
\(37 \text{ ones} \div 37: 1 \text{ one}\)

b. \(62,041 \times 37 = 2,295,517\)

5. \(952,448 \div 112\)

\[
\begin{array}{c|c|c}
\text{112} & \text{952448} & \text{8504} \\
-896 & -8504 & \\
-564 & -448 & \\
-448 & -448 & \\
\hline
0 & 0 & \\
\end{array}
\]

a. \(952 \text{ thousands} \div 112: 8 \text{ thousands}\)
\(564 \text{ hundreds} \div 112: 5 \text{ hundreds}\)
\(44 \text{ tens} \div 112: 0 \text{ tens}\)
\(448 \text{ ones} \div 112: 4 \text{ ones}\)

b. \(8,504 \times 112 = 952,448\)

6. \(1,823,535 \div 245\)

\[
\begin{array}{c|c|c}
\text{245} & \text{1823535} & \text{7443} \\
-490 & -7443 & \\
-1085 & -1653 & \\
-980 & -900 & \\
\hline
-735 & 0 & \\
\end{array}
\]

a. \(1,823 \text{ thousands} \div 245: 7 \text{ thousands}\)
\(1,085 \text{ hundreds} \div 245: 4 \text{ hundreds}\)
\(1,053 \text{ tens} \div 245: 4 \text{ tens}\)
\(735 \text{ ones} \div 245: 3 \text{ ones}\)

b. \(7,443 \times 245 = 1,823,535\)
Closing (2 minutes)

- Explain in your own words how the division algorithm works?
  - Answers will vary. Sample solution: The division algorithm shows, organized by place value, successive estimates of the quotient. Or students may answer, “The division algorithm breaks one large division problem into several smaller ones organized by place value.”

Exit Ticket (3 minutes)
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Exit Ticket

Divide using the division algorithm: 392,196 ÷ 87
Exit Ticket Sample Solutions

Divide using the division algorithm: \(392,196 \div 87\)

\[
\begin{array}{c|c}
87 & 4508 \\
\hline
392196 & -348 \\
-441 & -435 \\
-696 & -696 \\
& 0 \\
\end{array}
\]

Problem Set Sample Solutions

1. \(459,054 \div 54\)

\[
\begin{array}{c|c}
54 & 8501 \\
\hline
459054 & -432 \\
270 & -270 \\
054 & -54 \\
0 & 0 \\
\end{array}
\]

2. \(820,386 \div 102\)

\[
\begin{array}{c|c}
102 & 8043 \\
\hline
820386 & -816 \\
-438 & -408 \\
-306 & -306 \\
0 & 0 \\
\end{array}
\]

3. \(1,183,578 \div 227\)

\[
\begin{array}{c|c}
227 & 5214 \\
\hline
1183578 & -1135 \\
485 & -454 \\
317 & -317 \\
908 & -908 \\
0 & 0 \\
\end{array}
\]