You already know how to divide a multi-digit number by a one-digit divisor. Now you will learn how to divide with two-digit divisors. Use what you know to try to solve the problem below.

There are 92 fifth graders at Wilson Middle School and 23 students in each fifth-grade classroom. How many fifth-grade classrooms are there at Wilson Middle School?

**Math Toolkit**
- base-ten blocks
- base-ten grid paper
- grid paper
- index cards
- multiplication models

**DISCUSS IT**
*Ask your partner:* Can you explain that again?
*Tell your partner:* I started by . . .
CONNECT IT

1 LOOK BACK

What is 92 ÷ 23? Explain your reasoning.

2 LOOK AHEAD

Multiplication and division are called inverse operations because they “undo” each other. For example, the related multiplication and division equations 5 × 7 = 35 and 35 ÷ 5 = 7 show that if you multiply a number by 5 and then divide the result by 5, you end up with the number you started with.

Think about the related equations 264 ÷ 12 = ? and 12 × ? = 264.

You can use the related multiplication equation to help you divide.

a. Start by listing products of the divisor, 12, and multiples of 10.

<table>
<thead>
<tr>
<th>Multiple of 10</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 × Multiple 10</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Which row of the table above is related to the dividend in 264 ÷ 12? How could you use the table above to estimate the quotient 264 ÷ 12?

c. Start with 12 × a multiple of 10 to divide 264 by 12 using an area model. Complete the missing numbers.

\[
\begin{array}{c}
\text{12} \\
\text{264}
\end{array}
\rightarrow
\begin{array}{c}
\text{240} \\
\text{?}
\end{array}
\quad + \quad \ldots \quad = \quad \ldots
\]

3 REFLECT

How can you use the inverse relationship between multiplication and division to check your answer to 264 ÷ 12?
1. Think about what you know about division. Fill in each box. Use words, numbers, and pictures. Show as many ideas as you can.

<table>
<thead>
<tr>
<th>Word</th>
<th>In My Own Words</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>dividend</td>
<td></td>
<td></td>
</tr>
<tr>
<td>divisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>quotient</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Label the *dividend*, *divisor*, and *quotient* of the division equation shown by the area model. Then write the division equation.

```
\[ \text{Dividend} \div \text{Divisor} = \text{Quotient} \]
```
3 Solve the problem. Show your work.

There are 95 students on a field trip and 19 students on each bus. How many buses of students are there on the field trip?

Solution

4 Check your answer. Show your work.
Read and try to solve the problem below.

A toy company packs 504 robots into 21 boxes. Each box has the same number of robots. Show how you could estimate the number of robots in each box.

**TRY IT**

**Math Toolkit**
- base-ten blocks
- base-ten grid paper
- grid paper
- index cards
- multiplication models

**DISCUSS IT**

Ask your partner: How did you get started?
Tell your partner: I knew . . . so I . . .
Explore different ways to understand how to estimate quotients when dividing whole numbers.

A toy company packs 504 robots into 21 boxes. Each box has the same number of robots. Show how you could estimate the number of robots in each box.

**MODEL IT**

You can use compatible numbers to estimate a quotient.

Compatible numbers are numbers close to the values of the actual dividend and divisor that allow you to multiply or divide using basic facts.

500 and 20 are compatible numbers that are close to 504 and 21.

You can use them to estimate by thinking $500 \div 20 = ?$ means $20 \times ? = 500$.

**MODEL IT**

You can use the inverse relationship between multiplication and division to estimate a quotient.

$504 \div 21 = ?$ or $21 \times ? = 504$

Multiply 21 by multiples of 10. Make a table.

<table>
<thead>
<tr>
<th>Number of Robots per Box</th>
<th>Total Number of Robots</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>$21 \times 10 = 210$</td>
</tr>
<tr>
<td>20</td>
<td>$21 \times 20 = 420$</td>
</tr>
<tr>
<td>30</td>
<td>$21 \times 30 = 630$</td>
</tr>
</tbody>
</table>
CONNECT IT
Now you will use the problem from the previous page to help you understand how to estimate quotients with two-digit divisors.

1. Look at the first Model It. Why are 500 and 20 good choices to use for compatible numbers? Why not round to the nearest thousand and use 1,000 and 20 as compatible numbers?

2. How can you find the quotient 500 ÷ 20? What estimate does this give for the number of robots in each box?

3. Look at the second Model It. Why do you multiply 21 by multiples of 10? Could you multiply 21 by multiples of 5 instead of by multiples of 10?

4. Look at the table. Between which two numbers is a good estimate for the number of robots packed in each box? Explain how you know.

5. What do the methods of estimating quotients in the Model Its have in common?

6. REFLECT
   Look back at your Try It, strategies by classmates, and Model Its. Which models or strategies do you like best for estimating quotients? Explain.
APPLY IT
Use what you just learned to solve these problems.

7 Estimate the quotient $342 \div 38$. Show your work.

Solution

8 Estimate the quotient $1,103 \div 23$. Show your work.

Solution

9 Camille arranged 238 chairs into equal rows of 14 chairs. Which of the following is the best estimate for the number of rows she made?

A a number close to 30
B about 20
C a number between 30 and 40
D about 10
Practice Estimating Quotients

Study the Example showing how to estimate a quotient with a two-digit divisor. Then solve problems 1–4.

**EXAMPLE**

Estimate the quotient $1,474 \div 22$.

Choose compatible numbers that are close to the actual dividend and divisor and easy to multiply and divide using a basic fact.

1,400 and 20 are close to 1,474 and 22.

$2 \times 7 = 14$, $2 \times 70 = 140$, and $20 \times 70 = 1,400$.

$20 \times 70 = 1,400$ is the same as $1,400 \div 20 = 70$.

So, 70 is the estimated quotient for $1,474 \div 22$.

1. Look at the Example. You can also multiply 22 by **multiples of 10** to estimate the quotient $1,474 \div 22$.

   **a.** Complete the table.

<table>
<thead>
<tr>
<th>Multiple of 10</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>$22 \times$ Multiple of 10</td>
<td>220</td>
<td>440</td>
<td>660</td>
<td>880</td>
<td>1,100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   **b.** Complete the statement below with two numbers from the table.

   The dividend 1,474 is between .......... and .............

   **c.** What is a good estimate for the quotient $1,474 \div 22$?
2. Which of the following is the best estimate for the quotient $713 \div 31$?
   A. a number between 10 and 20
   B. a number close to 40
   C. a number close to 35
   D. a number between 20 and 30

3. A beverage company makes 1,008 bottles of water and packs them into boxes. The company packs 24 bottles in each box. Estimate how many boxes of water bottles the company packs. Show your work.

Solution

4. Marcus builds 2,744 kites for a 14-day summer kite festival. He plans to give away about the same number of kites each day. He gives away 492 kites the first two days. Did Marcus stick to his plan? Use estimation to explain. Show your work.

Solution
Read and try to solve the problem below.

A factory produces 768 buses and puts them in 24 buildings. Each building has the same number of buses. How many buses are in each building? Estimate and then solve.

**TRY IT**

**Math Toolkit**
- base-ten blocks
- base-ten grid paper
- grid paper
- index cards
- multiplication models

**DISCUSS IT**

Ask your partner: Do you agree with me? Why or why not?

Tell your partner: I agree with you about . . . because . . .
Explore different ways to understand how to divide multi-digit numbers using estimation and area models.

A factory produces 768 buses and puts them in 24 buildings. Each building has the same number of buses. How many buses are in each building? Estimate and then solve.

**MODEL IT**

You can use the relationship between multiplication and division to estimate the quotient.

$768 \div 24 = ?$ and $24 \times ? = 768$

Multiply 24 by **multiples of 10** to estimate the quotient.

You can organize your work in a table.

<table>
<thead>
<tr>
<th>Number of Buses in Each Building</th>
<th>Total Number of Buses</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>240</td>
</tr>
<tr>
<td>20</td>
<td>480</td>
</tr>
<tr>
<td>30</td>
<td>720</td>
</tr>
<tr>
<td>40</td>
<td>960</td>
</tr>
</tbody>
</table>

The quotient is between 30 and 40.

**MODEL IT**

You can use an area model to solve a division problem with a two-digit divisor.

The area model breaks up the problem $768 \div 24$ into parts.
**CONNECT IT**

Now you will use the problem from the previous page to help you understand how to divide multi-digit numbers using estimation and area models.

1. In the first Model It, how do you know the quotient is between 30 and 40?

2. Look at the second Model It. The number 24 is multiplied by which estimate, 30 or 40, to start the area model work? Why do you think the other number was not used?

3. What does the expression 30 + 2 above the area model represent?

4. Explain why the numbers 30 and 2 can be called *partial quotients*.

5. Explain how an area model can help you break apart a division problem to make it easier to solve.

**REFLECT**

Look back at your Try It, strategies by classmates, and Model Its. Which models or strategies do you like best for dividing whole numbers? Explain.
**APPLY IT**

Use what you just learned to solve these problems.

7. In the problem on the previous page, \(768 \div 24\), you first estimated and then used an area model to find the quotient. Describe how you can use multiplication to check that you have the correct quotient.

Show your work for the check.

8. Dante has 468 cards in his sports card collection. He buys cards in packages of 12. Complete the table and give an estimate for how many packages of cards Dante has bought.

<table>
<thead>
<tr>
<th>Number of packages</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sports cards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Solution**

9. Refer to the situation in problem 8. Complete the area model to find the quotient \(468 \div 12\). How many packages of sports cards did Dante buy?

**Solution**
Study the Example showing how to estimate and use area models to divide. Then solve problems 1–4.

**EXAMPLE**

A donut shop sells donuts in boxes that each contain 13 donuts. If 728 donuts were sold in one day, how many boxes of donuts were sold?

Multiply 13 by multiples of 10 to help you estimate the quotient. Make a table.

<table>
<thead>
<tr>
<th>Number of boxes</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of donuts</td>
<td>130</td>
<td>260</td>
<td>390</td>
<td>520</td>
<td>650</td>
<td>780</td>
</tr>
</tbody>
</table>

Because 728 is between 650 and 780, the quotient is between 50 and 60.

Use 50 as the first partial quotient in an area model for $728 \div 13$.

\[
\begin{array}{c}
\underline{728} \\
\underline{-650} \\
\hline
\underline{78}
\end{array}
\]

\[
\begin{array}{c}
\underline{728} \\
\underline{-650} \\
\hline
\underline{78}
\end{array}
\]

\[
\begin{array}{c}
\underline{728} \\
\underline{-650} \\
\hline
\underline{78}
\end{array}
\]

728 $\div$ 13 $=$ 56. The donut shop sold 56 boxes of donuts.

1. The area model in the Example shows how to break apart the problem $728 \div 13$ into parts.
   
   a. What was 13 multiplied by first? ........................................
   
   b. What equation in the area model shows this? ..........................
   
   c. Why do you subtract 650 from 728?
   
   d. What is the second partial quotient? .................................
2 The table can be used to estimate the quotient $851 \div 37$. Which of the following is the best estimate of the quotient?

<table>
<thead>
<tr>
<th>Multiple of 10</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>$37 \times \text{Multiple of 10}$</td>
<td>370</td>
<td>740</td>
<td>1,110</td>
<td>1,480</td>
</tr>
</tbody>
</table>

- A a number between 30 and 40
- B about 15
- C a number between 20 and 30
- D about 42

3 Complete the steps for using an area model to find the quotient $851 \div 37$.

$851 \div 37$ is the same as $\ldots \times ? = \ldots$.

? 

? 

? 

? 

? 

? 

? 

? 

? 

? 

$851 \div 37 = \ldots$

4 Which of the following equations cannot be used to represent the area model?

- A $42 \times ? = 4,326$
- B $42 + 4,326 = ?$
- C $4,326 \div ? = 42$
- D $4,326 \div 42 = ?$
Read and try to solve the problem below.

A grocery store only sells eggs by the dozen. There are 12 eggs in 1 dozen. If there are 1,248 eggs in stock, how many dozens of eggs are there?

**Math Toolkit**
- base-ten blocks
- base-ten grid paper
- grid paper
- index cards
- multiplication models

**DISCUSS IT**
*Ask your partner:* Why did you choose that strategy?
*Tell your partner:* I knew ... so I ...
Explore different ways to record partial products when dividing multi-digit whole numbers.

A grocery store only sells eggs by the dozen. There are 12 eggs in 1 dozen. If there are 1,248 eggs in stock, how many dozens of eggs are there?

**MODEL IT**

You can use an area model to record partial quotients.

Estimate to determine the first partial quotient for $1,248 \div 12$.

1,200 and 12 are compatible numbers close to the dividend and divisor.

$12 \times 100 = 1,200$, so you can use 100 as the first partial quotient in an area model.

\[
\begin{array}{c|c|c}
\text{12} & \text{1,248} & \text{12} \\
\hline
\end{array}
\]

\[
\begin{array}{c|c|c}
\text{100} & + & \text{4} \\
\hline
(12 \times 100 = 1,200) & & (12 \times 4 = 48) \\
\hline
1,248 & - 1,200 & 48 \\
\hline
48 & - 48 & 0 \\
\hline
\end{array}
\]

**MODEL IT**

You can use a vertical format to record partial quotients.

\[
\begin{align*}
4 & \quad \text{second partial quotient} \\
100 & \quad \text{first partial quotient} \\
12)1,248 & \quad \text{How many groups of 12 in 1,200?} \\
- 1,200 & \\
\hline
48 & \quad \text{How many groups of 12 in 48?} \\
- 48 & \\
\hline
0 & \\
\end{align*}
\]
**CONNECT IT**

Now you will use the problem from the previous page to help you understand how to record partial products in a vertical format.

1. Look at the second Model It. How many hundreds are in the dividend? How many groups of 12 are in 1,200? Notice that this first partial quotient is written above the bar.

2. After writing the first partial quotient above the bar, you write the number 1,200 under the dividend. What equation in the area model shows where the number 1,200 comes from?

3. Why is 1,200 subtracted from 1,248?

4. How does the area model relate to finding the second partial quotient?

5. Explain how to use the partial quotients to find $1,248 \div 12$. How many dozens of eggs does the grocery store have?

6. Describe how to divide using partial quotients.

7. **REFLECT**

   Look back at your Try It, strategies by classmates, and Model Its. Which models or strategies do you like best for recording partial products? Explain.
APPLY IT
Use what you just learned to solve these problems.

8 What is the quotient $583 \div 11$? Show your work.

9 Carlos has 1,134 pennies. He puts an equal number of pennies into 27 different glass jars. How many pennies are in each jar? Show your work.

Solution

10 Which of the following pairs of numbers are partial quotients for $594 \div 18$?

A 50 and 5
B 40 and 4
C 30 and 3
D 20 and 15
Practice Using Area Models and Partial Quotients to Divide

Study the Example showing division with a two-digit divisor using partial quotients. Then solve problems 1–5.

**EXAMPLE**

Find $1,386 \div 22$.

To divide using partial quotients, estimate a number that can be multiplied by the divisor to get a product less than or equal to the dividend. Then subtract the product from the dividend. Repeat these steps until you reach a number less than the divisor.

\[
\begin{align*}
22)1,386 & \rightarrow \text{How many groups of 20 in 1,200? 60} \\
-1,320 & \rightarrow 22 \times 60 \\
66 & \rightarrow \text{How many groups of 22 in 66? 3} \\
-66 & \rightarrow 22 \times 3 \\
0 & 
\end{align*}
\]

$1,386 \div 22 = 63$

1. Look at the Example. For the first step, Jaime thought: *How many groups of 20 in 1,400? There are 70.* If he continues with the division steps, when will he know that his first estimate of 70 is too high?

2. Multiply 14 by multiples of 10 to complete the table.

<table>
<thead>
<tr>
<th>Multiple of 10</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>$14 \times$ Multiple of 10</td>
<td>140</td>
<td>280</td>
<td>700</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Write a multiple of 10 from the table to show the greatest partial quotient to start with for each division problem below.

a. $14 \div 462$  
b. $14 \div 350$  
c. $14 \div 798$  
d. $14 \div 588$
3 Use an area model to find the quotient \( \frac{504}{14} \).

\[
\begin{array}{c|c|c}
14 & 284 & 14 \\
\hline
504 & -84 & \\
\hline
& & \end{array}
\]

\( 504 \div 14 = \ldots \)

4 A rectangular box has a volume of 504 cubic inches. The width of the box is 7 inches, and the height of the box is 6 inches. Use the partial quotient method shown in the example to find the length of the box. Show your work.

Solution

5 A hunger relief program ships boxes that hold 25 pounds of food. How many boxes will 2,350 pounds of food fill? Show your work.

Solution
Complete the Example below. Then solve problems 1–8.

**EXAMPLE**

Each package has 21 pieces of chalk. How many packages can be made with 1,701 pieces of chalk?

Look at how you could show your work using partial quotients.

\[
\begin{array}{c}
\phantom{-}1 \\
80 \\
\hline \\
21 \overline{1,701} \\
\hline \\
\phantom{-}1,680 \leftarrow 21 \times 80 \\
\hline \\
\phantom{-}21 \leftarrow 21 \times 1 \\
\hline \\
\phantom{-}0 \\
\end{array}
\]

**Solution**

Why is 80 a good number to use as a first partial quotient?

**PAIR/SHARE**

How can you use multiplication to check that the quotient is correct?

**APPLY IT**

1. A water cooler holds 1,284 ounces of water. How many more 6-ounce glasses than 12-ounce glasses can be filled from a full cooler? Show your work.

**Solution**

You can first estimate how many glasses of each size can be filled.

**PAIR/SHARE**

Explain how you found your estimate.
2. Each student needs 35 craft sticks for an art project. The art teacher has 7,140 craft sticks. The art teacher starts a division problem to determine how many students can get craft sticks from him. He was interrupted before he could complete the problem.

His partial work is shown below. Fill in the blanks to complete his work. Write your answers in the blanks.

\[
\begin{array}{c}
35)\ 7,140 \\
- \quad 7,000 \\
\quad 140 \\
- \quad 140 \\
\quad 0 \\
\end{array}
\]

3. Harrison creates balloon animals for different events. He has 6,440 balloons. He wants to use the same number of balloons for each of 28 events. How many balloons can Harrison use at each event?

A 23  
B 203  
C 230  
D 2,030

Tina chose A as the correct answer. How did she get that answer?
4. Mr. Kovich writes the problem $32 \times \triangle = 1,696$ on the board. Write a division equation that can be used to find the value of the triangle. Then find the value of the triangle. Show your work.

Solution

5. Vera makes a table to help her find the area of the base of a rectangular box with a volume of 672 cubic inches and a height of 16 inches.

<table>
<thead>
<tr>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>320</td>
<td>480</td>
<td>640</td>
<td>800</td>
<td>960</td>
</tr>
</tbody>
</table>

Choose the correct option to fill in each blank below.

The area of the base is between _________

- A 20
- B 30
- C 40
- D 60

and _________ square inches.

- A 30
- B 40
- C 50
- D 60

6. Lisa’s camera has 2,048 megabytes of memory for storing pictures. She has already used half this amount. A high-quality picture uses 16 megabytes of memory. How many high-quality pictures can Lisa store with the remaining memory?
Mr. Sullivan is organizing teams for the middle school’s annual field day. There are 8 classes at the school and 21 students in each class.

**Part A** What is the total number of students at the school?

\[ \text{students} \]

**Part B** Mr. Sullivan wants to have 12 students on each team. How many teams will there be?

\[ \text{teams} \]

**Part C** How many fewer students will be on each team if he decides to have 24 teams? Explain your answer using diagrams, pictures, mathematical expressions, and/or words.

\[ \text{fewer students} \]

**Math Journal**

Explain what you would do first to divide 1,260 by 28. Tell why it would be your first step.

**Self Check**

Go back to the Unit 1 Opener and see what you can check off.
What patterns can you find when you multiply or divide by 10, 100, or 1,000?

**MODEL IT**

Complete the problems below.

1. Numbers like 10, 100, or 1,000 that can be written as a product of tens are called **powers of 10**. Complete the equations to multiply 3 by a power of 10.

   $\times 10 \quad \times 10 \quad \times 10 \quad \times 10$

   3 $\rightarrow$ 30 $\rightarrow$ 300 $\rightarrow$ 3,000 $\rightarrow$ 30,000

   $\times 100$

   a. $3 \times 10 \times 10 = 3 \times \ldots$

      $= \ldots$

   b. $3 \times 10 \times 10 \times 10 = 3 \times \ldots$

      $= \ldots$

   c. $3 \times 10 \times 10 \times 10 \times 10 = 3 \times \ldots$

      $= \ldots$

2. Complete the equations to divide 30,000 by a power of 10.

   $\div 10 \quad \div 10 \quad \div 10 \quad \div 10$

   3 $\rightarrow$ 30 $\rightarrow$ 300 $\rightarrow$ 3,000 $\rightarrow$ 30,000

   $\div 100$

   $30,000 \div 100 = \ldots$

   $30,000 \div 10,000 = \ldots$

**DISCUSS IT**

- How did you and your partner determine the product or quotient in the equations?
- Patterns help me understand how to multiply or divide by numbers like 10, 100, or 1,000 because . . .
MODEL IT
Complete the problems below.

3. You can write a power of 10 using an exponent.
The exponent 4 means to use the base 10 as a factor 4 times.

\[ 10^4 = 10 \times 10 \times 10 \times 10 \]

Complete the table to show different ways to write the first three powers of 10.

<table>
<thead>
<tr>
<th>Standard Form</th>
<th>Product of Tens</th>
<th>Exponent Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>(10^1)</td>
</tr>
<tr>
<td>100</td>
<td>10 x 10 x 10</td>
<td>(10^2)</td>
</tr>
</tbody>
</table>

4. Complete the table to show different ways to write 300, 3,000, and 30,000.

<table>
<thead>
<tr>
<th>Standard Form</th>
<th>Using a Power of 10</th>
<th>Using Factors of 10</th>
<th>Exponent Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>(3 \times 100)</td>
<td>(3 \times 10 \times 10)</td>
<td>(3 \times 10^2)</td>
</tr>
<tr>
<td>3,000</td>
<td>(3 \times 1,000)</td>
<td>(3 \times)</td>
<td>(3 \times)</td>
</tr>
<tr>
<td>30,000</td>
<td>(3 \times)</td>
<td>(3 \times 10 \times 10 \times 10 \times 10)</td>
<td>(3 \times)</td>
</tr>
</tbody>
</table>

5. REFLECT
How do you know how many zeros are in the product \(5 \times 10^9\)? What is the product?
Prepare for Powers of 10

1. Think about what you know about powers of 10. Fill in each box. Use words, numbers, and pictures. Show as many ideas as you can.

2. Use the diagram to help you find each product.

\[ \begin{align*}
5 \times 10 & = 50 \\
5 \times 100 & = \ldots \\
5 \times 10,000 & = \ldots
\end{align*} \]
Solve.

3. Complete the table showing different ways to write powers of 10.

<table>
<thead>
<tr>
<th>Standard Form</th>
<th>Product of Tens</th>
<th>Exponent Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>$10 \times 10$</td>
<td>$10^2$</td>
</tr>
<tr>
<td>1,000</td>
<td>$10 \times 10 \times 10$</td>
<td>$10^3$</td>
</tr>
<tr>
<td>10,000</td>
<td>$10 \times 10 \times 10 \times 10$</td>
<td>$10^4$</td>
</tr>
</tbody>
</table>

4. Complete the table to show different ways to write 500, 5,000, and 50,000.

<table>
<thead>
<tr>
<th>Standard Form</th>
<th>Using a Power of 10</th>
<th>Using Factors of 10</th>
<th>Exponent Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>$5 \times 100$</td>
<td>$5 \times 10 \times 10$</td>
<td>$5 \times 10^2$</td>
</tr>
<tr>
<td>5,000</td>
<td>$5 \times 1,000$</td>
<td>5</td>
<td>$5 \times$</td>
</tr>
<tr>
<td>50,000</td>
<td>$5 \times$</td>
<td>$5 \times 10 \times 10 \times 10 \times 10$</td>
<td>$5 \times$</td>
</tr>
</tbody>
</table>

5. Rewrite each division equation to show the power of 10 in exponent form. Use the first pair of equations as an example.

$$5,000 \div 10 = 500 \quad \longrightarrow \quad 5,000 \div 10^1 = 500$$
$$5,000 \div 100 = 50 \quad \longrightarrow \quad 5,000 \div \ldots \ldots \ldots = 50$$
$$5,000 \div 1,000 = 5 \quad \longrightarrow \quad 5,000 \div \ldots \ldots \ldots = 5$$
LESSON 7
Develop Understanding of Powers of 10

MODEL IT: DECIMAL POINT PATTERNS
Try these two problems.

1 The diagrams below show patterns in the placement of the decimal point each time you multiply or divide a decimal by 10.

Complete the missing numbers in each diagram. The decimal point for each missing number is already placed for you.

2 Use the decimal point pattern diagrams above to help you find each product or quotient.

<table>
<thead>
<tr>
<th>Multiplication</th>
<th>Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.5 \times 100 = \ldots$</td>
<td>$0.27 \times 1,000 = \ldots$</td>
</tr>
<tr>
<td>$0.5 \times 10^2 = \ldots$</td>
<td>$0.27 \times 10^3 = \ldots$</td>
</tr>
<tr>
<td>$5 \div 100 = \ldots$</td>
<td>$2,700 \div 1,000 = \ldots$</td>
</tr>
<tr>
<td>$5 \div 10^2 = \ldots$</td>
<td>$2,700 \div 10^3 = \ldots$</td>
</tr>
</tbody>
</table>

DISCUSS IT
• What happens to the value of a number when you multiply or divide by a power of 10? Why?
• I think patterns in the placement of the decimal point help you multiply by 1,000 because . . .
MODEL IT: PLACE-VALUE CHARTS
Use place-value charts to show multiplying and dividing by powers of 10.

3 Complete each row with the product shown to the right of that row.

<table>
<thead>
<tr>
<th>Ones</th>
<th>.</th>
<th>Tenths</th>
<th>Hundredths</th>
<th>Thousandths</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>.</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0.005 \times 10^1
0.005 \times 10^2
0.005 \times 10^3

4 Complete each row with the quotient shown to the right of that row.

<table>
<thead>
<tr>
<th>Ones</th>
<th>.</th>
<th>Tenths</th>
<th>Hundredths</th>
<th>Thousandths</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5 \div 10^1
5 \div 10^2
5 \div 10^3

DISCUSS IT
• How do the values of the digits and the placement of the decimal point change when you multiply or divide any decimal by a power of 10?
• I think place-value charts show the pattern of multiplying and dividing by powers of 10 because . . .

CONNECT IT
Complete the problems below.

5 Look at the first decimal point pattern diagram and the place-value charts. How do the position and the value of the digit 5 change when multiplying and dividing by 10?

6 Show how to find the product 0.19 \times 10^3.
Study how the Example shows multiplying a decimal number by a power of 10. Then solve problems 1–7.

**EXAMPLE**

Find \(10^2 \times 0.004\).

Break \(10^2\) into the product of tens. 

\[
10^2 \times 0.004 = 10 \times 10 \times 0.004 = 10 \times 0.04 = 0.4
\]

The value of the digit 4 increases by moving one place to the left for each factor of 10.

1. Write the missing power of 10 in exponential form.
   a. \(0.04 \times \ldots = 0.4\)
   b. \(\ldots \times 0.006 = 0.6\)
   c. \(0.007 \times \ldots = 7\)

2. Complete the equations to find each product.
   a. \(8 \times 100 = 8 \times 10^2 = \ldots\)
   b. \(8 \times 1,000 = 8 \times \ldots = \ldots\)
   c. \(2 \times \ldots = 2 \times 10^1 = \ldots\)
   d. \(0.02 \times 100 = 0.02 \times \ldots = \ldots\)

3. Complete the equations.
   a. \(0.03 \times 1,000 = \ldots\)
   b. \(0.18 \times 100 = \ldots\)

**Vocabulary**

- **power of 10** a number that can be written as a product of tens.
  - \(10 = 10\)
  - \(100 = 10 \times 10\)
  - \(1,000 = 10 \times 10 \times 10\)

- **exponent** the number in a power that tells how many times to use the base as a factor.

\[
10^2 \quad \text{exponent}
\]

\[
10^2 = 10 \times 10, \text{ or } 100
\]
4. Use the place-value chart to show dividing 9 by powers of 10. Complete each row with the quotient shown to the right of the row.

<table>
<thead>
<tr>
<th>Ones</th>
<th>.</th>
<th>Tenths</th>
<th>Hundredths</th>
<th>Thousandths</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>.</td>
<td></td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>.</td>
<td></td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

5. Match each expression with its quotient.
   
   a. 5.2 \( \div 10 \) \quad 0.052
   
   b. 520 \( \div 10^2 \) \quad 0.52
   
   c. 52 \( \div 10^3 \) \quad 5.2
   
   d. 5,200 \( \div 10^1 \) \quad 520

6. Describe how the placement of the decimal point changes when you multiply a number by a power of ten. How is this the same and different for division?

7. Is multiplying by 10\(^3\) the same as multiplying by 10 factors of 3? Explain.
APPLY IT
Complete these problems on your own.

1. **COMPARE**

   Complete the place-value chart with the products and quotients shown to the right of the chart. Then write a sentence to compare the value of $0.8 \times 10^2$ to the value of $0.8 \div 10^2$.

<table>
<thead>
<tr>
<th>Tens</th>
<th>Ones</th>
<th>.</th>
<th>Tenths</th>
<th>Hundredths</th>
<th>Thousandths</th>
</tr>
</thead>
<tbody>
<tr>
<td>.</td>
<td></td>
<td>.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
<td>.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
<td>.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
<td>.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   $0.8 \times 10^2$

   $0.8 \times 10^1$

   $0.8 \div 10^1$

   $0.8 \div 10^2$

2. **INSPECT**

   Max says that the product $30 \times 10^4$ has exactly four zeros. Is he correct? Explain.

3. **EXPLAIN**

   How do you determine the value of the unknown exponent in the equation $9,700 \div 10^? = 0.97$?

**PAIR/SHARE**
Discuss your solutions for these three problems with a partner.
Use what you have learned to complete problem 4.

4 Jaime claims that when you multiply a whole number or a decimal by $10^2$, the placement of the decimal point in the product is always two places to the right of where it was in the factor.

Salome argues that the placement of the decimal point changes two places to the right only when you multiply a decimal by $10^2$. Salome says that when you multiply a whole number by $10^2$, you can put two extra zeros after the whole number to find the product.

Part A Explain each student’s point of view with examples.

Part B Which student is correct? Justify your answer.

5 Math Journal

Find the value of $80 \div 10^4$. Explain the change in value between 80 and $80 \div 10^4$. 