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Unit 5, Lesson 9: Using the Partial Quotients Method

1. Here is one way to find $2{,}105 \div 5$ using partial quotients.

```
  421
    1
   20
  400
5 ⟌2105
 −2000
  105
 −100
    5
  − 5
    0
```

Show a different way of using partial quotients to divide 2,105 by 5.

2. Andre and Jada both found $657 \div 3$ using the partial quotients method, but they did the calculations differently, as shown here.

```
  219
    9
   10
  200
3 ⟌657
 −600
   57
  −30
   27
  −27
    0
```

Andre's Work

```
  219
    9
   60
  100
   50
3 ⟌657
 −150
  507
 −300
  207
 −180
   27
  −27
    0
```

Jada's Work

a. How is Jada's work similar to and different from Andre's work?

b. Explain why they have the same answer.

3. Which might be a better way to evaluate $1{,}150 \div 46$: drawing base-ten diagrams or using the partial

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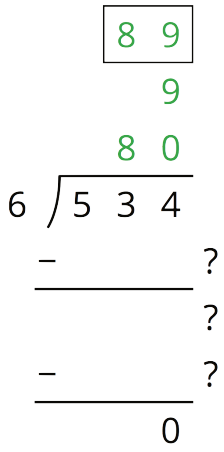
quotients method? Explain your reasoning.

4. Here is an incomplete calculation of $534 \div 6$.



Write the missing numbers (marked with "?") that would make the calculation complete.

5. Use the partial quotients method to find $1{,}032 \div 43$.

6. Which of the polygons has the greatest area?

A. A rectangle that is 3.25 inches wide and 6.1 inches long.
B. A square with side length of 4.6 inches.
C. A parallelogram with a base of 5.875 inches and a height of 3.5 inches.
D. A triangle with a base of 7.18 inches and a height of 5.4 inches.

(from Unit 5, Lesson 8)

7. One micrometer is a millionth of a meter. A certain spider web is 4 micrometers thick. A fiber in a shirt is 1 hundred-thousandth of a meter thick.

a. Which is wider, the spider web or the fiber? Explain your reasoning.

b. How many meters wider?

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(from Unit 5, Lesson 4)

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Unit 5, Lesson 9: Using the Partial Quotients Method

Calculate $4{,}235 \div 11$ using any method.

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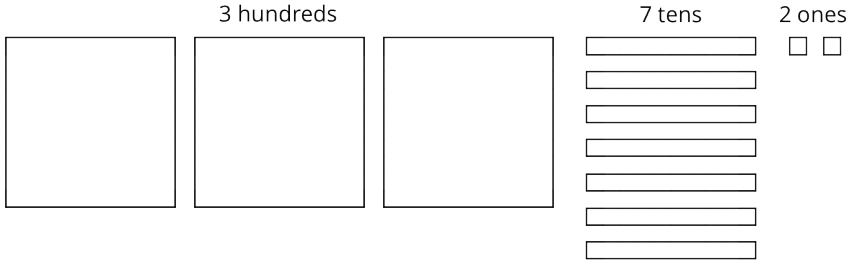
Unit 5, Lesson 9: Using the Partial Quotients Method

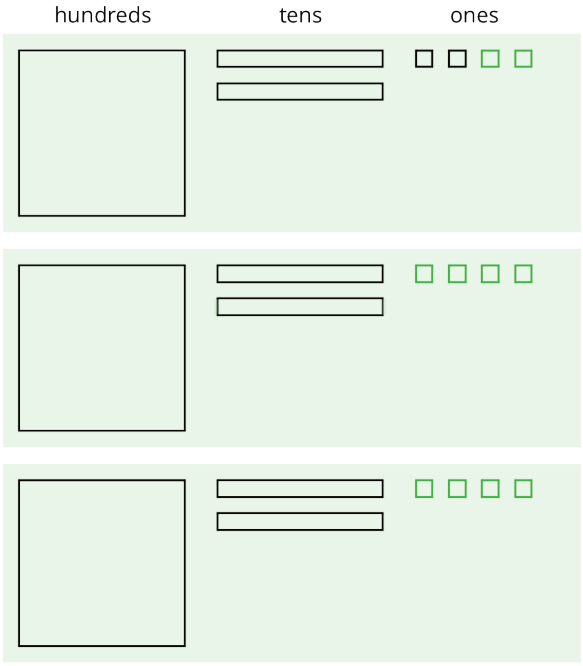
Let's divide whole numbers.

9.1: Using Base-Ten Diagrams to Calculate Quotients

Elena used base-ten diagrams to find $372 \div 3$. She started by representing 372.



She made 3 groups, each with 1 hundred. Then, she put the tens and ones in each of the 3 groups. Here is her diagram for $372 \div 3$.



Discuss with a partner:

- Elena's diagram for 372 has 7 tens. The one for $372 \div 3$ has only 6 tens. Why?
- Where did the extra ones (small squares) come from?

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9.2: Using the Partial Quotients Method to Calculate Quotients

1. Andre calculated $657 \div 3$ using a method that was different from Elena's.

He started by writing the dividend (657) and the divisor (3).	He then subtracted 3 groups of different amounts from 657, starting with 3 groups of 200 . . .	. . . then 3 groups of 10, and then 3 groups of 9.	Andre calculated 200 + 10 + 9 and then wrote 219.
$3 \overline{)\,6\,5\,7}$	$3 \overline{)\,6\,5\,7}$ $-\,6\,0\,0$ $5\,7$	$3 \overline{)\,6\,5\,7}$ $-\,6\,0\,0$ $5\,7$ $-\,3\,0$ $2\,7$ $-\,2\,7$ 0	$3 \overline{)\,6\,5\,7}$ $-\,6\,0\,0$ $5\,7$ $-\,3\,0$ $2\,7$ $-\,2\,7$ 0

Discuss the following questions with a partner:

- Andre subtracted 600 from 657. What does the 600 represent?
- Andre wrote 10 above the 200, and then subtracted 30 from 57. How is the 30 related to the 10?
- What do the numbers 200, 10, and 9 represent?
- What is the meaning of the 0 at the bottom of Andre's work?

2. How might Andre calculate $896 \div 4$? Explain or show your reasoning.

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9.3: What's the Quotient?

1. Find the quotient of $1{,}332 \div 9$ using one of the methods you have seen so far. Show your reasoning.

2. Find each quotient and show your reasoning. Use the partial quotients method at least once.

   a. $1{,}115 \div 5$ b. $665 \div 7$ c. $432 \div 16$

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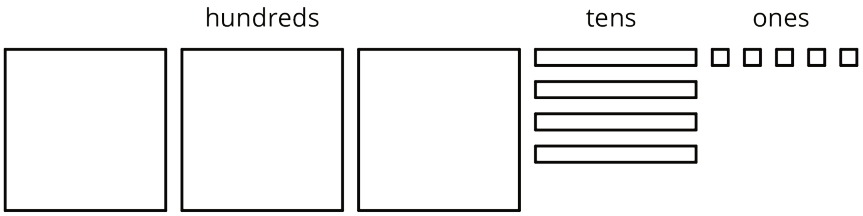
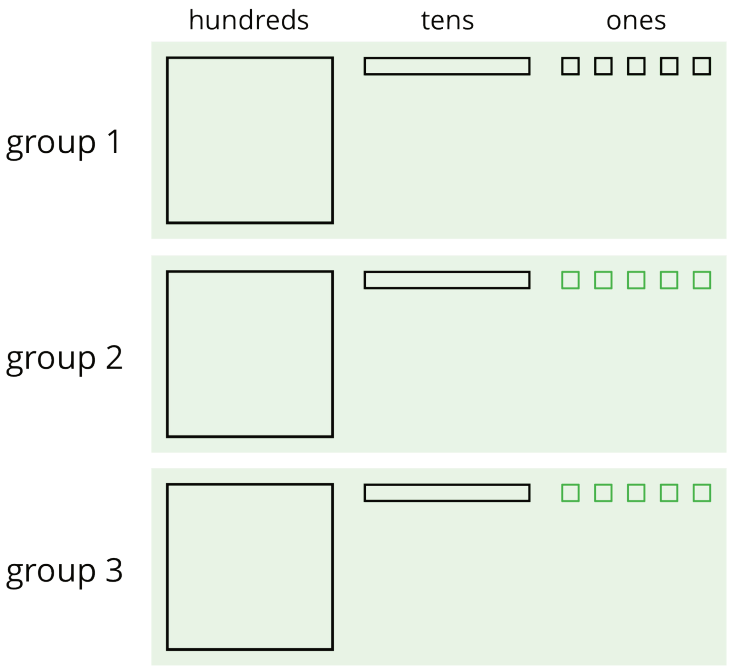
Lesson 9 Summary

We can find the quotient $345 \div 3$ in different ways.

One way is to use a base-ten diagram to represent the hundreds, tens, and ones and to create equal-sized groups.



We can think of the division by 3 as splitting up 345 into 3 equal groups.



Each group has 1 hundred, 1 ten, and 5 ones, so $345 \div 3 = 115$. Notice that in order to split 345 into 3 equal groups, one of the tens had to be unbundled or decomposed into 10 ones.

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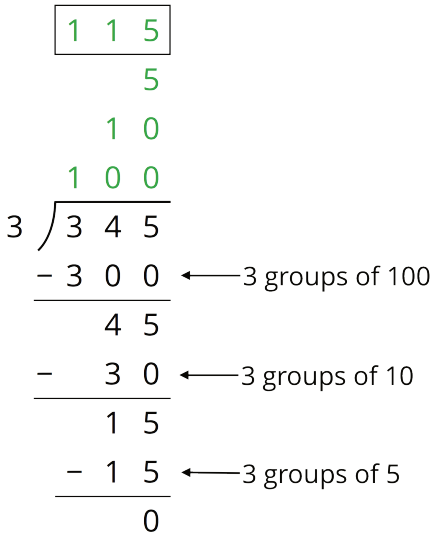
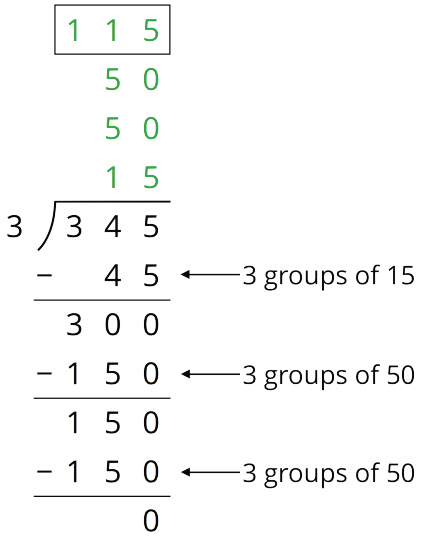
Another way to divide 345 by 3 is by using the partial quotients method, in which we keep subtracting 3 groups of some amount from 345.





- In the calculation on the left, first we subtract 3 groups of 100, then 3 groups of 10, and then 3 groups of 5. Adding up the partial quotients ($100 + 10 + 5$) gives us 115.

- The calculation on the right shows a different amount per group subtracted each time (3 groups of 15, 3 groups of 50, and 3 more groups of 50), but the total amount in each of the 3 groups is still 115. There are other ways of calculating $345 \div 3$ using the partial quotients method.

Both the base-ten diagrams and partial quotients methods are effective. If, however, the dividend and divisor are large, as in $1{,}248 \div 26$, then the base-ten diagrams will be time-consuming.

Unit 5, Lesson 9: Using the Partial Quotients Method

Lesson Goals

- Use base-ten diagrams and use the partial quotients method to find quotients of whole numbers when the dividend is a multiple of the divisor.

Required Materials

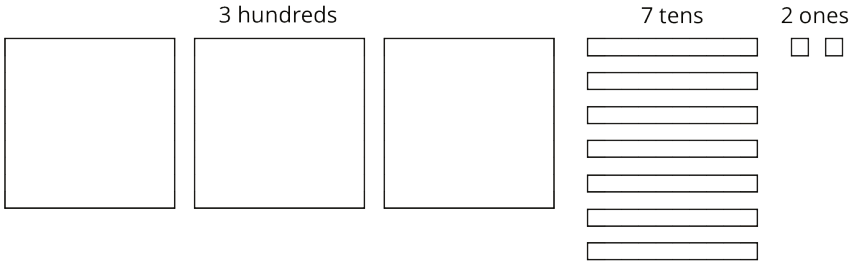
- graph paper

9.1: Using Base-Ten Diagrams to Calculate Quotients (5 minutes)

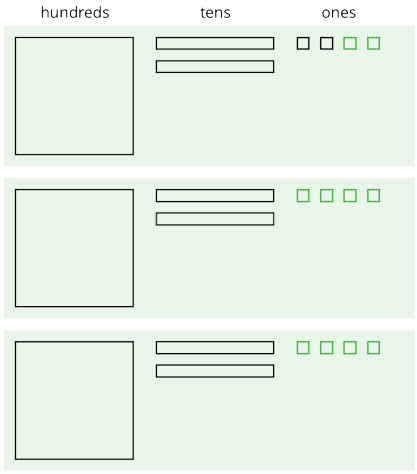
Setup: Students in groups of 2. 1 minute quiet think time, 2 minutes of partner discussion, followed by a whole-class discussion.

Student task statement

Elena used base-ten diagrams to find $372 \div 3$. She started by representing 372.



She made 3 groups, each with 1 hundred. Then, she put the tens and ones in each of the 3 groups. Here is her diagram for $372 \div 3$.



Discuss with a partner:

- Elena's diagram for 372 has 7 tens. The one for $372 \div 3$ has only 6 tens. Why?
- Where did the extra ones (small squares) come from?

Possible responses

Answers vary. Sample reasoning: Elena made 372 into 3 equal groups by working with like base-ten units separately—first the 3 hundreds, then 6 of the tens, and then the remaining 12 ones.

Anticipated misconceptions

If students have difficulty making sense of Elena's method, consider demonstrating her process with actual base-ten blocks or paper cutouts.

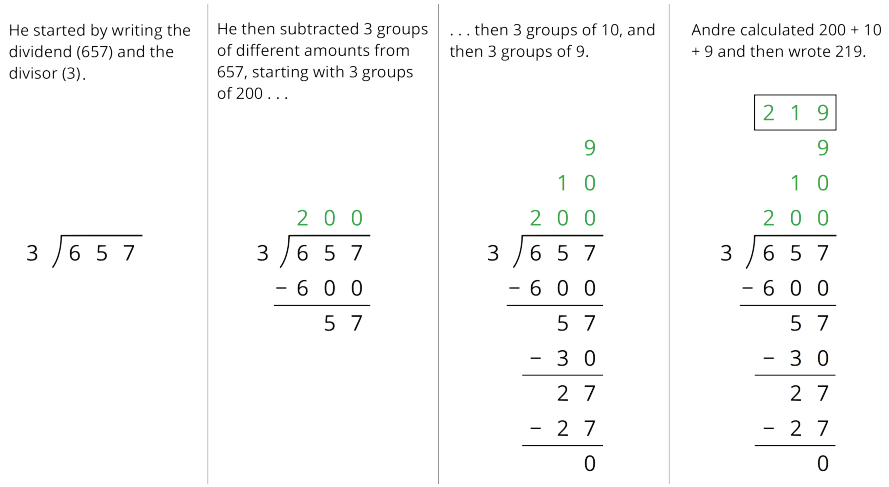
9.2: Using the Partial Quotients Method to Calculate Quotients (15 minutes)

Setup:

Students in groups of 2. 3–4 minutes discussing Elena's solution. 7–8 minutes of partner discussion on the first and second questions, then whole class discussion. Access to graph paper.

Student task statement

1. Andre calculated $657 \div 3$ using a method that was different from Elena's.



Discuss the following questions with a partner:

- Andre subtracted 600 from 657. What does the 600 represent?
- Andre wrote 10 above the 200, and then subtracted 30 from 57. How is the 30 related to the 10?
- What do the numbers 200, 10, and 9 represent?
- What is the meaning of the 0 at the bottom of Andre's work?

2. How might Andre calculate $896 \div 4$? Explain or show your reasoning.

Possible responses

1. Instead of using drawings to distribute base-ten units into equal groups, as Elena had done, Andre used numbers to do the same.

2. 224. See lesson plan for sample work.

Anticipated misconceptions

When using the partial quotients method, students might make subtraction or multiplication errors because they did not line up the numbers appropriately. Prompt students to compare the structure of Andre's work with their own or to check if they have aligned like units in their vertical calculations.

9.3: What's the Quotient? (15 minutes)

Setup: 2–3 minutes to discuss the first question with a partner. 8–10 minutes of quiet work time on the rest. Access to graph paper.

Student task statement

1. Find the quotient of $1{,}332 \div 9$ using one of the methods you have seen so far. Show your reasoning.

2. Find each quotient and show your reasoning. Use the partial quotients method at least once.

   a. $1{,}115 \div 5$ b. $665 \div 7$ c. $432 \div 16$

Possible responses

1. 148

2. a. 223
   b. 95
   c. 27

Lesson Synthesis (5 minutes)

How do we divide base-ten numbers using base-ten diagrams and the partial quotients method?

9.4: Dividing by 11 (Cool-down, 5 minutes)

Setup: None.

Student task statement

Calculate $4{,}235 \div 11$ using any method.

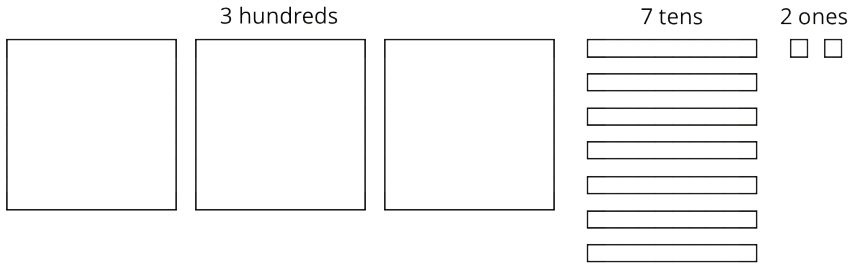
Possible responses

385

Unit 5, Lesson 9: Using the Partial Quotients Method

Student Facing Task Statement: Using Base-Ten Diagrams to Calculate Quotients

Elena used base-ten diagrams to find $372 \div 3$. She started by representing 372.



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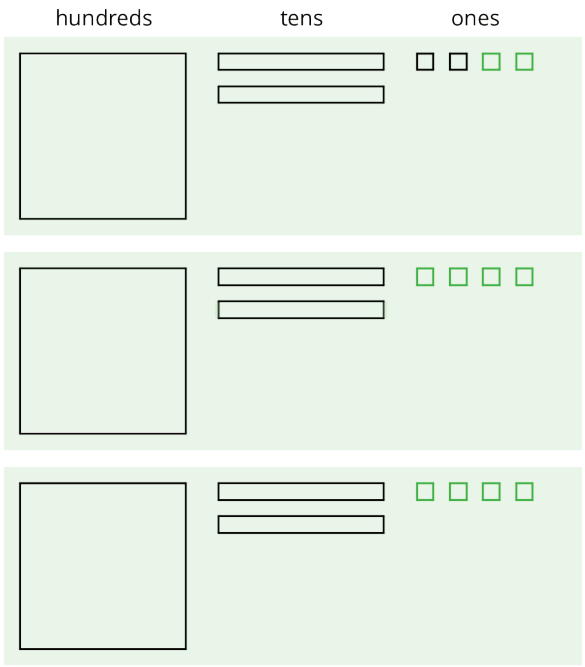
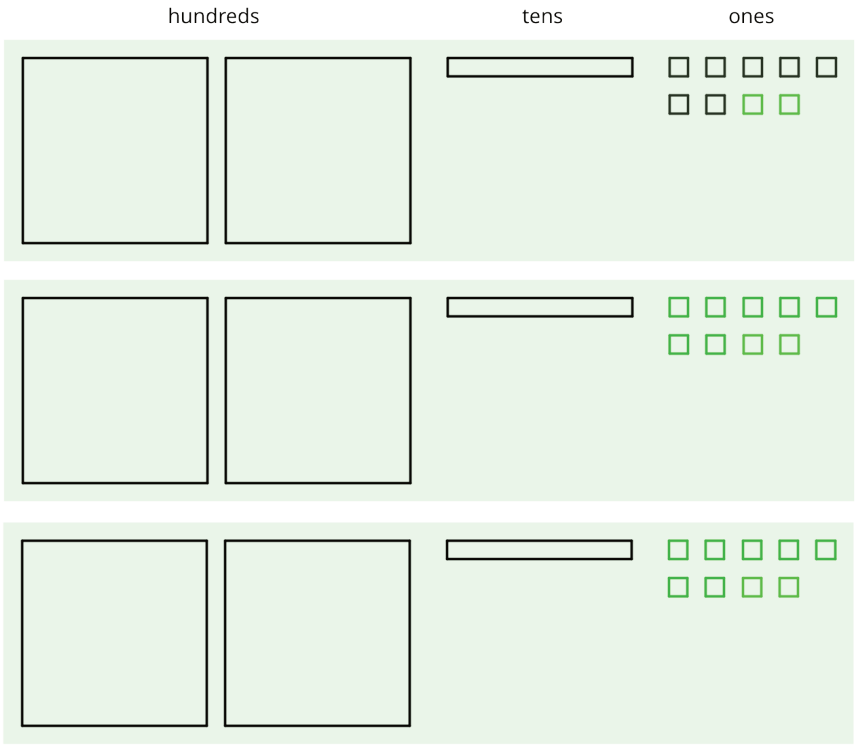


Discuss with a partner:

- Elena's diagram for 372 has 7 tens. The one for $372 \div 3$ has only 6 tens. Why?
- Where did the extra ones (small squares) come from?

Launch: Using the Partial Quotients Method to Calculate Quotients



Student Facing Task Statement: Using the Partial Quotients Method to Calculate Quotients

1. Andre calculated $657 \div 3$ using a method that was different from Elena's.

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$3\overline{)657}$	$\begin{array}{r} 200 \\ 3\overline{)657} \\ -600 \\ \hline 57 \end{array}$	$\begin{array}{r} 9 \\ 10 \\ 200 \\ 3\overline{)657} \\ -600 \\ \hline 57 \\ -30 \\ \hline 27 \\ -27 \\ \hline 0 \end{array}$	$\begin{array}{r} \boxed{219} \\ 9 \\ 10 \\ 200 \\ 3\overline{)657} \\ -600 \\ \hline 57 \\ -30 \\ \hline 27 \\ -27 \\ \hline 0 \end{array}$

Discuss the following questions with a partner:

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   a. $1{,}115 \div 5$

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Student Facing Task Statement: Dividing by 11

Calculate $4{,}235 \div 11$ using any method.