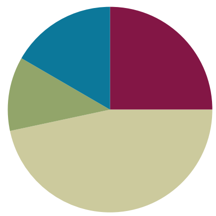
Lesson 3

Objective: Use exponents to name place value units and explain patterns in the placement of the decimal point.

Suggested Lesson Structure

Fluency Practice	(15 minutes)
Application Problems	(7 minutes)
Concept Development	(28 minutes)
Student Debrief	(10 minutes)
Total Time	**(60 minutes)**



Fluency Practice (15 minutes)

- Multiply by 3 **3.OA.7** (8 minutes)
- State the Unit as a Decimal **5.NBT.2** (4 minutes)
- Multiply by 10, 100, and 1000 **5.NBT.2** (3 minutes)

Sprint: Multiply by 3 (8 minutes)

Materials: (S) Multiply by 3 Sprint.

Notes: This fluency will review foundational skills learned in Grades 3 and 4.

State the Unit as a Decimal—Choral Response (4 minutes)

Notes: Reviewing these skills will help students work towards mastery of decimal place value, which will help them apply their place value skills to more difficult concepts.

T: (Write 9 tenths = ____.)
S: 0.9
T: (Write 10 tenths = ____.)
S: 1.0
T: Write 11 tenths = ____.)
S: 1.1
T: (Write 12 tenths = ____.)
S: 1.2
T: (Write 18 tenths = ____.)

S: 1.8
T: (Write 28 tenths = ____.)
S: 2.8
T: (Write 58 tenths = ____.)
S: 5.8

Repeat the process for 9 hundredths, 10 hundredths, 20 hundredths, 60 hundredths, 65 hundredths, 87 hundredths, and 118 tenths. (This last item is an extension.)

Multiply and Divide by 10, 100, and 1000 (3 minutes)

Materials: (S) Personal white boards.

Notes: This fluency drill will review concepts taught in Lesson 2.

T: (Project place value chart from millions to thousandths.) Write two 1 thousandths disks and the number below it.
S: (Students write two 1 thousandths disks in the thousandths column. Below it, they write 0.002.)
T: Multiply by 10. Cross out each disk and the number 2 to show that you're changing its value.
S: (Students cross out each 1 thousandths disk and the 2. They draw arrows to the hundredths column and write two 1 hundredth disks. Below it, they write 2 in the hundredths column and 0 in the ones and tenths column.)

Repeat the process for the possible sequence: 0.004 x 100; 0.004 x 1000; 1.004 x 1000; 1.024 x 100; 1.324 x 100; 1.324 x 10; and 1.324 x 1000.

Repeat the process for dividing by 10, 100, and 1000 for this possible sequence: 4 ÷ 10; 4.1 ÷ 10; 4.1 ÷ 100; 41 ÷ 1000; and 123 ÷ 1000.

Application Problem (7 minutes)

Jack and Kevin are creating a mosaic by using fragments of broken tiles for art class. They want the mosaic to have 100 sections. If each section requires 31.5 tiles, how many tiles will they need to complete the mosaic? Explain your reasoning with a place value chart.

NOTES ON MULTIPLE MEANS OF ACTION AND EXPRESSION:

Very large numbers like *one million* and beyond easily capture the imagination of students. Consider allowing students to research and present to classmates the origin of number names like *googol* and *googleplex*. Connections to literacy can also be made with books about large numbers, such as *How Much is a Million* by Steven Kellogg, *A Million Dots* by Andrew Clements, *Big Numbers and Pictures That Show Just How Big They Are* by Edward Packard and Sal Murdocca.

The following benchmarks may help students appreciate just how large a *googol* is.

- There are approximately 10^{24} stars in the observable universe.
- There are approximately 10^{80} atoms in the observable universe.
- A stack of 70 numbered cards can be ordered in approximately 1 *googol* different ways. That means that that the number of ways a stack of only 70 cards can be shuffled is more than the number of atoms in the observable universe.

Concept Development (28 minutes)

Materials: (S) Personal white boards

Problem 1

T: (Draw or project chart, adding numerals as discussion unfolds.)

				100	10
				10 x 10	10 x 1

T: (Write 10 × ____ = 10 on the board.) On your personal board, fill in the missing factor to complete this number sentence.

S: (Students write.)

T: (Write 10 × ____ = 100 on the board.) Fill in the missing factor to complete this number sentence.

S: (Students write.)

T: This time, using only 10 as a factor, how could you multiply to get a product of 1000? Write the multiplication sentence on your personal board.

S: 10 x 10 x 10 = 1000.

T: Work with your partner. What would the multiplication sentence be for 10,000 using only 10 as a factor? Write on your personal board.

S: (Students write.)

MP.7

T: How many factors of 10 did we have to multiply to get to 1000?

S: 3.

T: How many factors of 10 do we have to multiply to get 10,000?

S: 4.

T: Say the number sentence.

S: 10 x 10 x 10 x 10 = 10,000.

T: How many zeros are in our product, 10,000?

S: 4 zeros.

T: What patterns do you notice? Turn and share with your partner.

S: The number of zeros is the same on both side of the equation. → The number of zeros in the product is the same as the number of zeros in the factors. → I see three zeros on the left side, and there are three zeros on the right side for 10 x 10 x 10 = 1000. → The 1 moves one place to the left every time we multiply by 10. → It's like a place value chart. Each number is 10 times as much as the last one.

MP.7

T: Using this pattern, how many factors of 10 do we have to multiply to get 1 million? Work with your partner to write the multiplication sentence.

S: (Students write.)

T: How many factors of 10 did you use?

S: 6

T: Why did we need 6 factors of 10?

S: 1 million has 6 zeros.

T: We can use an **exponent** (write term on the board) to represent how many times we use 10 as a factor. We can write 10 x 10 as 10^2. (Add to the chart.) We say, "Ten to the second power." The *2* (point to exponent) is the exponent and it tells us how many times to use 10 as a factor.

T: How do you express 1000 using exponents? Turn and share with your partner.

S: We multiply 10 × 10 × 10, that's three times, so the answer is 10^3. → There are three zeros in 1000, so it's ten to the third power.

T: Working with your partner, complete the chart using the exponents to represent the each value on the place value chart.

1,000,000	100,000	10,000	1000	100	10
(10 x 10 x 10) x (10 x 10 x 10)	10x 10 x (10 x 10 x 10)	10 x (10 x 10 x 10)	(10 x 10 x 10)	10 x 10	10 x 1
10^6	10^5	10^4	10^3	10^2	10^1

After reviewing the chart with the students, challenge them to multiply 10 one hundred times. As some start to write it out, others may write 10^{100}, a *googol*, with exponents.

T: Now look at the place value chart; let's read our powers of 10 and the equivalent values.

S: Ten to the second power equals 100; ten to the third power equals 1000. (Continue to read chorally up to 1 million.)

T: Since a *googol* has 100 zeros, write it using an exponent on your personal board.

S: (Students write 10^{100}.)

NOTES ON MULTIPLE MEANS OF REPRESENTATIONS:

Providing non-examples is a powerful way to clear up mathematical misconceptions and generate conversation around the work. Highlight those examples such as 10^5 pointing out its equality to 10 x 10 x 10 x 10 x 10 but not to 10 x 5 or even 5^{10}.

Allowing students to explore a calculator and highlighting the functions used to calculate these expressions (e.g., 10^5 versus 10 x 5) can be valuable.

Problem 2

10^5

T: Write *ten to the fifth power* as a product of tens.

S: 10^5 = 10 x 10 x 10 x 10 x 10.

T: Find the product.

S: 10^5 = 100,000.

Repeat with more examples as needed.

Problem 3

10 x 100

T: Work with your partner to write this expression using an exponent on your personal board. Explain your reasoning.

S: I multiply 10 x 100 to get 1000, so the answer is ten to the third power. → There are 3 factors of 10. → There are three 10's. I can see one 10 in the first factor and 2 more tens in the second factor.

Repeat with 100 x 1000 and other examples as needed.

Problems 4–5

3 x 10^2

3.4 x 10^3

T: Compare this expression to the ones we've already talked about.

S: These have factors other than 10.

T: Write 3 x 10^2 without using an exponent. Write it on your personal board.

S: 3 x 100.

T: What's the product?

S: 300.

T: If you know that 3 × 100 is 300, then what is 3 x 10^2? Turn and explain to your partner.

S: The product is also 300. 10^2 and 100 are same amount so the product will be the same.

T: Use what you learned about multiplying decimals by 10, 100, and 100 and your new knowledge about exponents to solve 3.4 x 10^3 with your partner.

S: (Students work.)

Repeat with 4.021 x 10^2 and other examples as needed.

Have students share their solutions and reasoning about multiplying decimal factors by powers of ten. In particular, students should articulate the relationship between the exponent and how the values of the digits change and placement of the decimal in the product.

Problems 6–7

700 ÷ 10^2

7.1 ÷ 10^2

T: Write 700 ÷ 10^2 without using an exponent and find the quotient. Write it on your personal board.

S: 700 ÷ 100 = 7

T: If you know that 700 ÷ 100 is 7, then what is 700 ÷ 10^2? Turn and explain to your partner.

S: The quotient is 7 because 10^2 = 100.

T: Use what you know about dividing decimals by multiples of 10 and your new knowledge about exponents to solve 7.1 ÷ 10^2 with your partner.

S: (Students work.)

T: Tell your partner what you notice about the relationship between the exponents and how the values of the digits change. Also discuss how you decided where to place the decimal.

Repeat with more examples as needed.

Problems 8–9

Complete this pattern: 0.043 4.3 430 _________ _________ __________

T: (Write the pattern on the board.) Turn and talk with your partner about the pattern on the board. How is the value of the 4 changing as we move to the next term in the sequence? Draw a place value chart to explain your ideas as you complete the pattern and use an exponent to express the relationships.

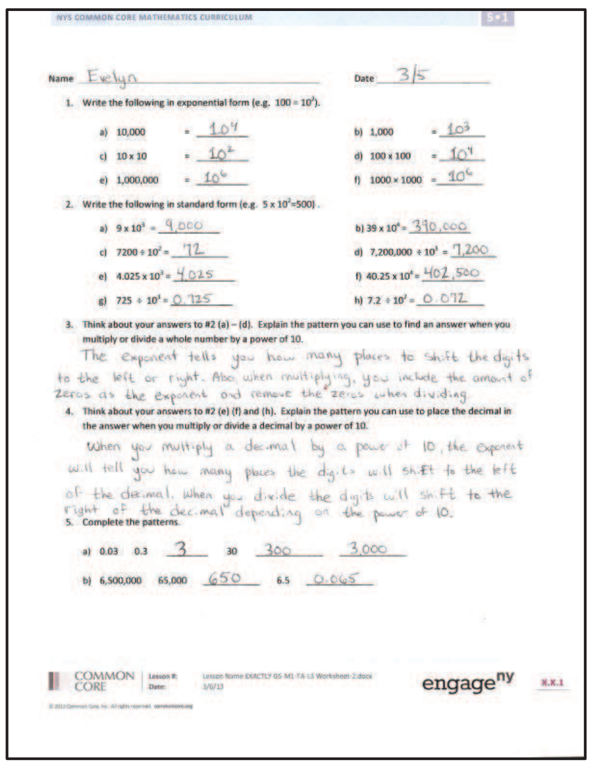
S: The 4 moved two places to the left. → Each number is being multiplied by 100 to get the next one. → Each number is multiplied by 10 twice. → Each number is multiplied by 10^2.

Repeat with 6,300,000; ____; 630; 6.3; _____ and other patterns as needed.

T: As you work on the Problem Set, be sure you are thinking about the patterns that we've discovered today.

Problem Set (10 minutes)

Students should do their personal best to complete the Problem Set within the allotted 10 minutes. For some classes, it may be appropriate to modify the assignment by specifying which problems they work on first. Some problems do not specify a method for solving. Students solve these problems using the RDW approach used for Application Problems.



NYS COMMON CORE MATHEMATICS CURRICULUM 5•1

Name Evelyn Date 3/5

1. Write the following in exponential form (e.g. $100 = 10^2$).

a) 10,000 = 10^4 b) 1,000 = 10^3

c) 10 x 10 = 10^2 d) 100 x 100 = 10^4

e) 1,000,000 = 10^6 f) 1000 × 1000 = 10^6

2. Write the following in standard form (e.g. $5 \times 10^2 = 500$).

a) 9×10^3 = 9,000 b) 39×10^4 = 390,000

c) $7200 \div 10^2$ = 72 d) $7,200,000 \div 10^3$ = 7,200

e) 4.025×10^3 = 4,025 f) 40.25×10^4 = 402,500

g) $725 \div 10^3$ = 0.725 h) $7.2 \div 10^2$ = 0.072

3. Think about your answers to #2 (a) – (d). Explain the pattern you can use to find an answer when you multiply or divide a whole number by a power of 10.

The exponent tells you how many places to shift the digits to the left or right. Also when multiplying, you include the amount of zeros as the exponent and remove the zeros when dividing

4. Think about your answers to #2 (e) (f) and (h). Explain the pattern you can use to place the decimal in the answer when you multiply or divide a decimal by a power of 10.

When you multiply a decimal by a power of 10, the exponent will tell you how many places the digits will shift to the left of the decimal. When you divide the digits will shift to the right of the decimal depending on the power of 10.

5. Complete the patterns.

a) 0.03 0.3 3 30 300 3,000

b) 6,500,000 65,000 650 6.5 0.065

COMMON CORE Lesson #: Lesson Name EXACTLY G5-M1-TA-L3 Worksheet-2.docx Date: 3/6/13 engage^ny X.X.1

Student Debrief (10 minutes)

Lesson Objective: Use exponents to name place value units and explain patterns in the placement of the decimal point.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience.

Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson. You may choose to use any combination of the questions below to lead the discussion.

- What is an **exponent** and how can exponents be useful in representing numbers? (This question could also serve as a prompt for math journals. Journaling about new vocabulary throughout the year can be a powerful way for students to solidify their understanding of new terms.)
- How would you write 1000 using exponents? How would you write it as a multiplication sentence using only 10 as a factor?
- Explain to your partner the relationship we saw between the exponents and the number of the places the digit shifted when you multiply or divide by a power of 10.
- How are the patterns you discovered in Problem 3 and 4 in the Problem Set alike?


NYS COMMON CORE MATHEMATICS CURRICULUM 5•1

c) 94,300 9,430 943 94.3 9.43 0.943

d) 999 9990 99,900 999,000 9,990,000 99,900,000

e) 0.075 7.5 750 75,000 7,500,000 750,000,000

f) Explain how you found the missing numbers in set (b). Be sure to include your reasoning about the number of zeros in your numbers and how you placed the decimal.

I noticed that the next number in the pattern had two zeros less than the number before, so the numbers were being divided by 10^2. That means the numbe shifts two places to the right.

g) Explain how you found the missing numbers in set (e). Be sure to include your reasoning about the number of zeros in your numbers and how you placed the decimal.

I noticed that the whole numbers added two zeros, so the numbers were 10^2 greater from the previous number. That helped me know to shift 7.5 two places to the right and get 0.075.

6. Shaunnie and Marlon missed the lesson on exponents. You notice that Shaunnie incorrectly wrote $10^5 = 50$ on her paper, and you notice that Marlon incorrectly wrote $2.5 \times 10^2 = 2.500$ on his paper.

a. What mistake has Shaunnie made? Explain to her using words, numbers and pictures why her thinking is incorrect and what she needs to do to correct her answer.

Shaunie thinks that 10^5 is 10×5. $10^5 = 10 \times 10 \times 10 \times 10 \times 10$. $10^5 = 100{,}000$.

b. What mistake has Marlon made? Explain to Marlon using words, numbers and pictures why his thinking is incorrect and what he needs to do to correct his answer.

Marlon made the mistake of just adding zeros at the end of 2.5. He needs to remember that multiplying by 10^2 makes a number 100 times greater, which is 25.

COMMON CORE Lesson #: Lesson Name EXACTLY G5-M1-TA-L3 Worksheet-2.docx engage^ny X.X.2

Give students plenty of opportunity to discuss the error patterns in Problem 6(a) and 6(b). These are the most common misconceptions students hold when dealing with exponents, so it is worth the time to see that they do not become firmly held.

Exit Ticket (3 minutes)

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students' understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.

A # Correct ______

Multiply.

1	1 x 3 =		23	10 x 3 =	
2	3 x 1 =		24	9 x 3 =	
3	2 x 3 =		25	4 x 3 =	
4	3 x 2 =		26	8 x 3 =	
5	3 x 3 =		27	5 x 3 =	
6	4 x 3 =		28	7 x 3 =	
7	3 x 4 =		29	6 x 3 =	
8	5 x 3 =		30	3 x 10 =	
9	3 x 5 =		31	3 x 5 =	
10	6 x 3 =		32	3 x 6 =	
11	3 x 6 =		33	3 x 1 =	
12	7 x 3 =		34	3 x 9 =	
13	3 x 7 =		35	3 x 4 =	
14	8 x 3 =		36	3 x 3 =	
15	3 x 8 =		37	3 x 2 =	
16	9 x 3 =		38	3 x 7 =	
17	3 x 9 =		39	3 x 8 =	
18	10 x 3 =		40	11 x 3 =	
19	3 x 10 =		41	3 x 11 =	
20	3 x 3 =		42	12 x 3 =	
21	1 x 3 =		43	3 x 13 =	
22	2 x 3 =		44	13 x 3 =	

B Improvement _____ # Correct _____

Multiply.

1	3 x 1 =		23	9 x 3 =	
2	1 x 3 =		24	3 x 3 =	
3	3 x 2 =		25	8 x 3 =	
4	2 x 3 =		26	4 x 3 =	
5	3 x 3 =		27	7 x 3 =	
6	3 x 4 =		28	5 x 3 =	
7	4 x 3 =		29	6 x 3 =	
8	3 x 5 =		30	3 x 5 =	
9	5 x 3 =		31	3 x 10 =	
10	3 x 6 =		32	3 x 1 =	
11	6 x 3 =		33	3 x 6 =	
12	3 x 7 =		34	3 x 4 =	
13	7 x 3 =		35	3 x 9 =	
14	3 x 8 =		36	3 x 2 =	
15	8 x 3 =		37	3 x 7 =	
16	3 x 9 =		38	3 x 3 =	
17	9 x 3 =		39	3 x 8 =	
18	3 x 10 =		40	11 x 3 =	
19	10 x 3 =		41	3 x 11 =	
20	1 x 3 =		42	13 x 3 =	
21	10 x 3 =		43	3 x 13 =	
22	2 x 3 =		44	12 x 3 =	

Name ____ Date ____________________

1. Write the following in exponential form (e.g., $100 = 10^2$).

a. 10,000 = __________

b. 1000 = _________

c. 10 x 10 = __________

d. 100 x 100 = _________

e. 1,000,000 = __________

f. 1000 × 1000 = _________

2. Write the following in standard form (e.g., $5 \times 10^2 = 500$).

a. 9×10^3 = ____________

b. 39×10^4 = ____________

c. $7200 \div 10^2$ = ___________

d. $7{,}200{,}000 \div 10^3$ = _________

e. 4.025×10^3 = ____________

f. 40.25×10^4 = ____________

g. $725 \div 10^3$ = ____________

h. $7.2 \div 10^2$ = _____________

3. Think about the answers to Problem 2(a–d). Explain the pattern used to find an answer when you multiply or divide a whole number by a power of 10.

4. Think about the answers to Problem 2(e–h). Explain the pattern used to place the decimal in the answer when you multiply or divide a decimal by a power of 10.

5. Complete the patterns.

   a. 0.03 0.3 ________ 30 ______________ ______________

   b. 6,500,000 65,000 ____________ 6.5 ______________

   c. __________ 9,430 __________ 94.3 9.43 ___________

   d. 999 9990 99,900 ___________ ___________ ____________

   e. __________ 7.5 750 75,000 ___________ ____________

   f. Explain how you found the missing numbers in set (b). Be sure to include your reasoning about the number of zeros in your numbers and how you placed the decimal.

   g. Explain how you found the missing numbers in set (d). Be sure to include your reasoning about the number of zeros in your numbers and how you placed the decimal.

6. Shaunnie and Marlon missed the lesson on exponents. Shaunnie incorrectly wrote $10^5 = 50$ on her paper, and Marlon incorrectly wrote $2.5 \times 10^2 = 2.500$ on his paper.

   a. What mistake has Shaunnie made? Explain using words, numbers, and pictures why her thinking is incorrect and what she needs to do to correct her answer.

   b. What mistake has Marlon made? Explain using words, numbers, and pictures why his thinking is incorrect and what he needs to do to correct his answer.

Name ____ Date ______________________

1. Write the following in exponential form and as a multiplication sentence using only 10 as a factor (e.g., $100 = 10^2 = 10 \times 10$).

   a. 1,000 = ______________ = ______________

   b. 100 × 100 = ______________ = ______________

2. Write the following in standard form (e.g., $4 \times 10^2 = 400$).

   a. $3 \times 10^2 =$ ______________

   b. $2.16 \times 10^4 =$ ______________

   c. $800 \div 10^2 =$ ______________

   d. $754.2 \div 10^3 =$ ______________

Name ____ Date ______________

1. Write the following in exponential form (e.g., $100 = 10^2$).

a. 1000 = __________

b. 10 × 10 = _________

c. 100,000 = __________

d. 100 x 10 = _________

e. 1,000,000 = __________

f. 10,000 × 10 = _________

2. Write the following in standard form (e.g., $4 \times 10^2 = 400$).

a. 4×10^3 = ____________

b. 64×10^4 = ____________

c. $5300 \div 10^2$ = ___________

d. $5{,}300{,}000 \div 10^3$ = _________

e. 6.072×10^3 = ____________

f. 60.72×10^4 = ____________

g. $948 \div 10^3$ = ____________

h. $9.4 \div 10^2$ = _____________

3. Complete the patterns.

a. 0.02 0.2 __________ 20 __________ __________

b. 3,400,000 34,000 __________ 3.4 __________

c. __________ 8,570 __________ 85.7 8.57 __________

d. 444 4440 44,400 __________ __________ __________

e. __________ 9.5 950 95,000 __________ __________

4. After a lesson on exponents, Tia went home and said to her mom, "I learned that 10^4 is the same as 40,000." She has made a mistake in her thinking. Use words, numbers or a place value chart to help Tia correct her mistake.

5. Solve $247 \div 10^2$ and 247×10^2.

   a. What is different about the two answers? Use words, numbers or pictures to explain how the decimal point shifts.

   b. Based on the answers from the pair of expressions above, solve $247 \div 10^3$ and 247×10^3.