5.NBT.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

Mechanics

Teacher Notes: This standard extends and builds upon 5.NBT.1 and all the 4th grade standards in this domain. Working with whole number exponents is new to fifth graders. Here, they will deepen their grasp of place value to understand why multiplying or dividing by powers of ten results in a shift of the decimal point to the right or to the left.

Multiplying tens by tens results in a product called a power of 10. The numbers 10, 100, 1,000, 10,000, 100,000, and 1,000,000 are powers of 10. Sometimes an exponent is used to show a power of 10. The exponent shows how many times the base is used as a factor. In the equation $10^2 = 10 \times 10$, the base (10) is used as a factor 2 times.

The **base** is the number that is raised to a power. The **exponent** shows how many times the base is used as a factor. Another word for exponent is **power**. In the example below, say "ten to the power of five" or "ten to the fifth power."

base → 10^5 ← exponent

$\underbrace{10 \times 10 \times 10 \times 10 \times 10}_{\text{factors}} = 10^5$

We can show the product of 10×10 in different ways. This is the way you have seen it before: $10 \times 10 = 100$.

We can also write the product using an exponent: $10 \times 10 = 10^2$.
(Say, "Ten times ten is ten squared or ten to the second power.")

So, all three forms name the same number: $10 \times 10 = 10^2 = 100$

Examples

Write the product using an exponent. $10 \times 10 \times 10 =$ 10^3

Write the product using an exponent. $10 \times 10 \times 10 \times 10 \times 10 =$ 10^5

Write the product using an exponent. $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 =$ 10^7

Write the product using an exponent. $10 \times 10 \times 10 \times 10 =$ 10^4

Write the product using an exponent. $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 =$ 10^8

Names of Powers	
Power	**Words**
10^4	10 to the fourth power
10^2	10 to the second power or **10 squared**
10^3	10 to the third power or **10 cubed**

Once students are comfortable with writing the products of 10 using exponents, they can continue on to find values from the power of 10 as a product of the same factor. The exponent shows how many 0s to add after the 1. So $10^2 = 10 \times 10 = 100$

Power of 10	Exponent	Standard Form	Number of Zeros
10^1	1	10	1
10^2	2	100	2
10^3	3	1,000	3
10^4	4	10,000	4

The number of zeros in the product increases when the power of ten increases.

Write the power of 10 as a product of the same factor.

$10^4 =$ 10 × 10 × 10 × 10 = 10,000

Write the power of 10 as a product of the same factor.

$10^6 =$ 10 × 10 × 10 × 10 × 10 × 10 = 1,000,000

Write the power of 10 as a product of the same factor.

$10^5 =$ 10 × 10 × 10 × 10 × 10 = 100,000

Write the power of 10 as a product of the same factor.

$10^8 =$ 10 × 10 × 10 × 10 × 10 × 10 × 10 × 10 = 100,000,000

Write the power of 10 as a product of the same factor.

$10^3 =$ 10 × 10 × 10 = 1,000

The standard also requires students to be able to "explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10."

Find 23×10^4			
Look at the power of 10. Write 10^4 without exponents. **10,000**	Count the number of zeros in 10,000. **4**	Write the same number of zeros to the right of 23. **230000**	The product of 23×10^4 is **230,000**

Find the product: $14 \times 10^2 =$ _____ Answer: 1,400

Find the product: $57 \times 10^6 =$ _____ Answer: 57,000,000

Find the product: $6 \times 10^2 =$ _____ Answer: 600

Find the product: $32 \times 10^1 =$ _____ Answer: 320

Find the product: $97 \times 10^3 =$ _____ Answer: 97,000

Find the product for each problem. Describe the pattern in the number of zeros in each product.

$412 \times 10^2 =$ 41,200

$412 \times 10^3 =$ 412,000

Possible descriptions could include the exponent increased by one. The second problem has one additional zero. *Teachers should also add to the description that the decimal point at the end of the number is what moves over; the empty spots are filled with the zeros.*

Find the product for each problem. Describe the pattern in the number of zeros in each product.

$9 \times 10^6 =$ 9,000,000

$9 \times 10^9 =$ 9,000,000,000

Possible descriptions could include the exponent increased by three. The second problem has three additional zeros. *Teachers should also add to the description that the decimal point at the end of the number is what moves over; the empty spots are filled with the zeros.*

Find the product for each problem. Describe the pattern in the number of zeros in each product.

$21 \times 10^5 =$ 2,100,000

$21 \times 10^7 =$ 210,000,000

Possible descriptions could include the exponent increased by two. The second problem has two additional zeros. *Teachers should also add to the description that the decimal point at the end of the number is what moves over; the empty spots are filled with the zeros.*

Find the product for each problem. Describe the pattern in the number of zeros in each product.

$522 \times 10^4 =$ 5,220,000

$522 \times 10^3 =$ 522,000

Possible descriptions could include the exponent decreased by one. The second problem has one less zero. *Teachers should also add to the description that the decimal point at the end of the number is what moves over; the empty spots are filled with the zeros.*

Find the product for each problem. Describe the pattern in the number of zeros in each product.

$15 \times 10^8 =$ 1,500,000,000

$15 \times 10^5 =$ 1,500,000

Possible descriptions could include the exponent decreased by three. The second problem has three less zeros. *Teachers should also add to the description that the decimal point at the end of the number is what moves over; the empty spots are filled with the zeros.*

Once students understand that multiplying by a power of 10 can determine how many zeros to add to the end of a number, they will then be introduced to the concept that moving the decimal point to the right is really multiplying by powers of ten.

To multiply a decimal by a power of 10, move the decimal point to the right the same number of zeros in the power of ten. This is also the same number as the exponent of 10.

Find 13.147×10^2			
Look at the power of 10. Write 10^2 without exponents. **100**	Count the number of zeros in 100. **2**	Move the decimal point to the right two spaces. **13.14.7**	The product of 13.147×10^2 is **1,314.7**

$0.247 \times 10^2 =$ _____ Answer: 24.7

$1.6478 \times 10^4 =$ _____ Answer: 16,478

$78.4 \times 10^1 =$ _____ Answer: 784

Find 23.4×10^3			
Look at the power of 10. Write 10^3 without exponents. **1,000**	Count the number of zeros in 1000. **3**	Move the decimal point to the right three spaces. **23.400.**	The product of 23.4×10^3 is **23,400**

$0.23 \times 10^5 =$ _____ Answer: 23,000

$72.1 \times 10^4 =$ _____ Answer: 721,000

$1.146 \times 10^2 =$ _____ Answer: 114.6

Find the product for each problem. Describe the pattern in the placement of the decimal point.

$14.12 \times 10^2 =$ 1,412

$14.12 \times 10^1 =$ 141.2

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the right because we multiplied.*

Find the product for each problem. Describe the pattern in the placement of the decimal point.

$1.578 \times 10^4 =$ 15,780

$1.578 \times 10^3 =$ 1,578

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the right because we multiplied.*

Find the product for each problem. Describe the pattern in the placement of the decimal point.

$20.1876 \times 10^2 =$ 2,018.76

$20.1876 \times 10^3 =$ 20,187.6

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the right because we multiplied.*

Find the product for each problem. Describe the pattern in the placement of the decimal point.

$53.4871 \times 10^2 =$ 5,348.71

$53.4871 \times 10^4 =$ 534,871

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the right because we multiplied.*

Find the product for each problem. Describe the pattern in the placement of the decimal point.

$487.34 \times 10^1 =$ 4,873.4

$487.34 \times 10^3 =$ 487,340

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the right because we multiplied.*

Students will also divide by powers of 10. The connection to multiplying will be an easy transition as long as they realize that dividing by powers of ten is really moving the decimal point to the left.

Find $324.7 \div 10^2$			
Look at the power of 10. Write 10^2 without exponents. **100**	Count the number of zeros in 100. **2**	Move the decimal point to the left two spaces. **3.24.7**	The quotient of $324.7 \div 10^2$ is **3.247**

$45.21 \div 10^2 =$ _____ Answer: 0.4521

$7{,}642.14 \div 10^3 =$ _____ Answer: 7.64214

$78.4 \div 10^1 =$ _____ Answer: 7.84

Find $12.41 \div 10^3$			
Look at the power of 10. Write 10^3 without exponents. **1,000**	Count the number of zeros in 1,000. **3**	Move the decimal point to the left three spaces. **0.012.41**	The quotient of $12.41 \div 10^3$ is **0.01241**

$3.189 \div 10^4 =$ _____ Answer: 0.0003189

$45.2 \div 10^5 =$ _____ Answer: 0.000452

$0.24 \div 10^1 =$ _____ Answer: 0.024

Add zeros to the beginning of the number if needed.

Find the quotient for each problem. Describe the pattern in the placement of the decimal point.

$25.14 \div 10^1 =$ 2.514

$25.14 \div 10^2 =$ 0.2514

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the left because we divided.*

Find the quotient for each problem. Describe the pattern in the placement of the decimal point.

$345.8 \div 10^3 =$ 0.3458

$345.8 \div 10^2 =$ 3.458

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the left because we divided.*

Find the quotient for each problem. Describe the pattern in the placement of the decimal point.

$876 \div 10^2 =$ 8.76

$876 \div 10^1 =$ 87.6

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the left because we divided.*

Find the quotient for each problem. Describe the pattern in the placement of the decimal point.

$23.5 \div 10^4 =$ 0.00235

$23.5 \div 10^1 =$ 2.35

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the left because we divided.*

Find the quotient for each problem. Describe the pattern in the placement of the decimal point.

$164.187 \div 10^3 =$ 0.164187

$164.187 \div 10^4 =$ 0.0164187

Possible descriptions could include the decimal point was moved the same number of spaces as the exponent. *Teachers should point out that the decimal point is moved to the left because we divided.*

Concept Mastery

- ✓ Students are able to use whole-number exponents to denote powers of 10.
- ✓ Students are able to explain patterns in the number of zeros of the product when multiplying a number by powers of 10.
- ✓ Students are able to explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10.

A link to helpful web resources can be found on page 135 of the full Level 5 document.