Lesson 1

UNDERSTAND PLACE-VALUE PATTERNS

5.NBT.A.1, 5.NBT.A.2

WORDS TO KNOW

power of 10

exponent

place value

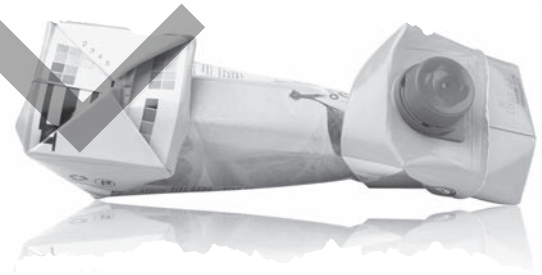
digit

inverse operations

INTRODUCTION

Real-World Connection

Watson Elementary School is collecting and recycling used juice pouches. The school will receive $0.19 for each juice pouch it collects. How much money will the school receive if it collects 10, 100, 1,000, or 10,000 juice pouches? Let's practice the skills in the **Guided Instruction** and **Independent Practice** and see how much money the school might receive!



What I Am Going to Learn

- The difference in a digit's value based on its place in a number
- How the value of a number changes when zeros are added
- How the value of a number changes by the location of the decimal point
- How a number is changed when multiplied or divided by a power of 10

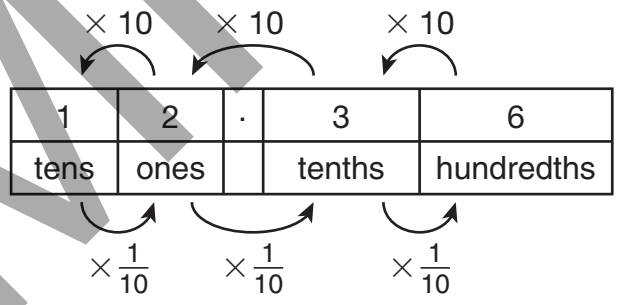
What I May Already Know

4.NBT.A.1, 4.NBT.B.5, 4.NBT.B.6

- I know how to multiply and divide with multi-digit numbers.
- I know that the place value to the right is 10 times larger: 700 is 10 times more than 70.

Vocabulary in Action

- A **power of 10** is the number 10 multiplied by itself a number of times.
  - For each time 10 is multiplied, a zero is added: $10 \times 10 = 100$, $10 \times 10 \times 10 = 1{,}000$, $10 \times 10 \times 10 \times 10 = 10{,}000$, and so on.
  - A power of 10 can be written with an **exponent**, a small number written to the top right of the number, telling you how many times 10 was multiplied and how many zeros appear in the product: $10^3 = 10 \times 10 \times 10 = 1{,}000$: 3 zeros
- **Place value** is determined by powers of 10.
  - $10^0 = 1$, $10^1 = 10$, $10^2 = 100$, $10^3 = 1{,}000$, and so on.
  - Each place value is 10 times larger than the place to the right and $\frac{1}{10}$ as much as the place to the left.
  - The value of a **digit** is determined by its place value:



  - In the diagram above, the value of the digit 1 is 10 because it is in the tens place.
  - The value of the digit 2 is 2 because it is in the ones place.
  - The value of the digit 3 is 0.3 because it is in the tenths place.
  - The value of the digit 6 is 0.06 because it is in the hundredths place.
- Multiplying and dividing by a power of 10 are **inverse operations**.
  - Multiplying by a power of 10 shifts the digits to the *left* of the decimal point the same number of places as the exponent: $354.56 \times 10^2 = 354.56 \times 100 = 35{,}456$. Each digit is 100 times larger.
  - Dividing by a power of 10 shifts the digits to the *right* of the decimal point the same number of places as the exponent: $354.56 \div 10^2 = 3.5456$. Each digit is 100 times smaller.

EXAMPLE

What is 49.33×100?

You are multiplying by 10 two times, so the digits shift to the left two places. Each digit is 100 times larger.

$49.33 \times 100 = 49.33 \times 10 \times 10 = 4{,}933$

A microscope can magnify very small things by powers of 10.

TURN AND TALK

When you write a whole number, where is the decimal point?

When multiplying or dividing by a power of 10, the power will often be written as an exponent. It is much easier to write 5.4×10^9 than $5.4 \times 1{,}000{,}000{,}000$.

EXAMPLE

What is 7.92×10^4?

$7.92 \times 10^4 = 7.92 \times 10 \times 10 \times 10 \times 10 = 79{,}200$

You are multiplying by 10 four times. The exponent tells to you shift the digits to the left four places.

A telescope lets us see things that are distant by magnifying by powers of 10.

THINK ABOUT IT

The zeros were added after 792 as place holders so that we know that the 7, 9, and 2 shifted 4 places to the left.

GUIDED INSTRUCTION

Money is one situation where you multiply or divide by powers of 10. If you have \$4.35, you have 4.35×100 pennies, or 435 pennies.

1. Compare the value of the 6 in the number 0.26 to the value of the 6 in the number 6.13.

Step One What is the value of the digit 6 in 0.26?

0	0	.	2	6
tens	ones		tenths	hundredths

The value of the digit 6 is 0.06.

Step Two What is the value of the digit 6 in 6.13?

0	6	.	1	3
tens	ones		tenths	hundredths

The value of the digit 6 is 6 ones.

Step Three Compare the values.

The value of the 6 in 0.26 is $\frac{1}{100}$ the value of the 6 in 6.13.

The value of 6 in 6.13 is 100 times the value of the 6 in 0.26.

2. Write the number 100,000 as a power of 10 using an exponent.

Step One How many zeros are in 100,000?

There are [ ] zeros in 100,000.

Step Two 10 is multiplied 5 times.

$100{,}000 = 10 \times 10 \times 10 \times 10 \times 10$

Step Three The exponent is 5.

$100{,}000 =$ [ ]

3. What is $49.33 \div 10^2$?

Step One Change 10^2 to its power of 10.

$49.33 \div 100 =$

Step Two Change division to multiplication.

$49.33 \times \frac{1}{100} =$

Step Three Since you are multiplying by $\frac{1}{100}$, each place value shifts 2 places to the right.

$49.33 \times \frac{1}{100} = 0.$ ☐

4. Use the numbers in the box to make the equations correct. The numbers cannot be used more than once. Write each number in the appropriate box.

0.021	0.21	2.1	21	210

$0.21 \times 100 =$ ☐

$0.21 \div 10 =$ ☐

☐ $\times 100 = 210$

TURN AND TALK

Why is multiplying by $\frac{1}{100}$ the same as dividing by 100?

HINT, HINT

Will the decimal number be smaller or larger after it is multiplied? Will it be smaller or larger after it is divided?

TURN AND TALK

Work with a partner. Exponents are often used in science to describe very large or small measures. Using exponential form eliminates working with too many zeros. The planet Jupiter is an average of 4.8×10^8 miles from the sun. What is that number when multiplied?

How Am I Doing?

What questions do you have?

What can you think of that is 10 times as long as a pencil? What is $\frac{1}{10}$ as long?

What are some other situations where you have seen powers of 10?

Color in the traffic signal that shows how you are doing with the skill.

INDEPENDENT PRACTICE

Answer the questions.

1. How many zeros are in $20 \times 100{,}000$?

   Ⓐ 1 Ⓑ 5

   Ⓒ 6 Ⓓ 7

2. Which of the following expressions are equivalent to 1,000,000? Select the **two** correct answers.

   Ⓐ $1 \times 1 \times 1 \times 1 \times 1 \times 1$

   Ⓑ $10 \times 10 \times 10 \times 10 \times 10 \times 10$

   Ⓒ $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$

   Ⓓ 1^6

   Ⓔ 10^6

3. Circle the option that correctly completes the statement.

   The value of the 2 in 21.3 is [$\frac{1}{100}$ / $\frac{1}{10}$ / 10 more than / 100 more than / 10 times / 100 times] the value of the 2 in the number 12.7.

4. Use the symbols in the box to make the equations correct.

   The symbols cannot be used more than once. Write each symbol in the appropriate box.

+	−	×	÷

   2.31 [ ] 1,000 = 0.00231 2.31 [ ] 10 = 23.1

TIPS AND TRICKS

Each incorrect answer in a multiple-choice question represents a common mistake. Try to identify the mistake that could lead to each answer choice.

WORK SPACE

WORK SPACE

5. Use the numbers in the box to make the equations correct.

Numbers can be used more than once. Write each number in the appropriate box.

0.4	4	40	400	4,000

$0.4 \times 1{,}000 =$ ☐ $0.04 \times 10{,}000 =$ ☐

☐ $\times \frac{1}{100} = 40$

6. Part A

What is 1.76×10^3?

Write your answer in the box.

☐

Part B

Explain how you found your answer.

7. Ravi says that the product of 30 and 10^4 has 4 zeros. Explain why Ravi is incorrect.

▶ TIPS AND TRICKS

When you are asked to explain your answer, explain both what you did and why you did it.

EXIT TICKET

5.NBT.A.1, 5.NBT.A.2

Now that you've mastered multiplying and dividing by powers of 10, let's solve the problem in the **Real-World Connection**.

Watson Elementary School is collecting and recycling used juice pouches. The school will receive $0.19 for each juice pouch it collects. How much money will the school receive if it collects 10, 100, 1,000, or 10,000 juice pouches?

10 pouches: $_____

100 pouches: $_____

1,000 pouches: $_____

10,000 pouches: $_____