LESSON

7.4 Powers of 10

How can we express powers of 10 using exponents?

Students begin by writing repeated factors in exponential form. They look at the special case of powers of 10 and represent them with blocks ($10 \times 1 = 10^1 = 10$, $10 \times 10 = 10^2 = 100$, etc.) They consider layers of packing and unpacking and relate this to the exponents for powers of 10 (10^1, 10^2, 10^3, 10^{-1}, and 10^{-2}). They observe that no packing, 10^0, equals 1. Students use powers of 10 in expanded notation to describe multi-digit numbers.

Objectives

- To learn how to use exponents when describing repeated factors of the same number
- To write powers of 10 using exponential notation, including $10^0 = 1$
- To use powers of 10 and expanded notation to describe multi-digit numbers

Materials

- 1 block of each size (1, 10, 100, 1000, 0.1, and 0.01)

E*ach group will need:*

- 100 blocks (packed)
- tenth blocks
- hundredth blocks

- Both *Exponents and Powers of 10* activity sheet **for each student**

◆ Class Introduction 30 MIN.

- Write a multiplication problem on the board with multiples of the same number. Model how to write the problem as an exponent. For example:

$$3 \times 3 \times 3 \times 3 = 3^4$$

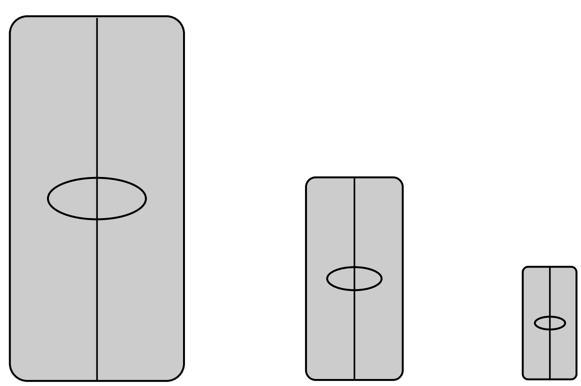
Explain,

Exponents tell us how many times to multiply the same number.

Present other examples, each time challenging the students to write the problem in terms of exponents.

$7 \times 7 \times 7 \times 5 \times 5 = 7^3 \times 5^2$	**→ $343 \times 25 =$**
$5 \times 5 \times 4 \times 5 = 5^3 \times 4$, or we could write $5^3 \times 4^1$	**→ $125 \times 4 =$**

- Line up a block-of-1000, a block-of-100, and a block-of-10. (You will discuss the single block later) Ask students to identify the number of groups of 10 in each block.



$1000 = 10 \times 10 \times 10 = 10^3$

$100 = 10 \times 10 = 10^2$

$10 = 10 = 10^1$

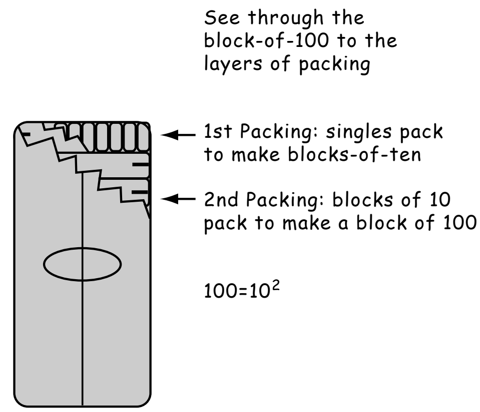
block-of-10:	**$10 = 1 \times 10$**	**$10^1=10$**
block-of-100:	**$100 = 10 \times 10$**	**$10^2 = 100$**
block-of-1000:	**$1000 = 10 \times 10 \times 10$**	**$10^3 = 1000$**
(continue the pattern for larger powers of 10)		
block-of-10,000:	**$10{,}000 = 10 \times 10 \times 10 \times 10$**	**$10^4 = 10{,}000$**
block-of-100,000:	**$100{,}000 = 10 \times 10 \times 10 \times 10 \times 10$**	**$10^5 = 100{,}000$**

Discuss patterns in the way we use exponents to describe powers of 10. Students should see that the exponents increase by 1 each time. Ask,

What is a quick way to determine the exponent for a power of 10? *(Count how many places the digit 1 has shifted from the ones place.)*

- The successive layers of packing of the blocks provide another way to think about exponents. Each time we pack, we have gathered 10 of a particular size. That is, we have multiplied by 10. Point out this pattern to the class:

Blocks are packed once to make a block-of-10.	**$10 = 10^1$**
Blocks are packed twice – blocks-of-10, then a block-of-100.	**$100 = 10^2$**
Blocks are packed three times – blocks-of-10, blocks-of-100, then a block-of-1000.	**$1000 = 10^3$**
And so on	



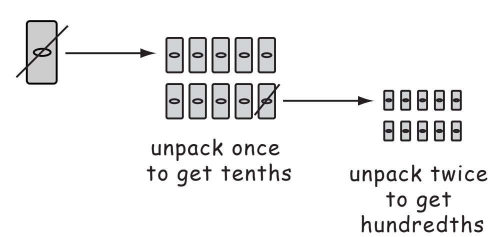
- Extend the display to include a single block, a tenth block, and a hundredth block. Talk about continuing the pattern for smaller powers of 10. Ask,

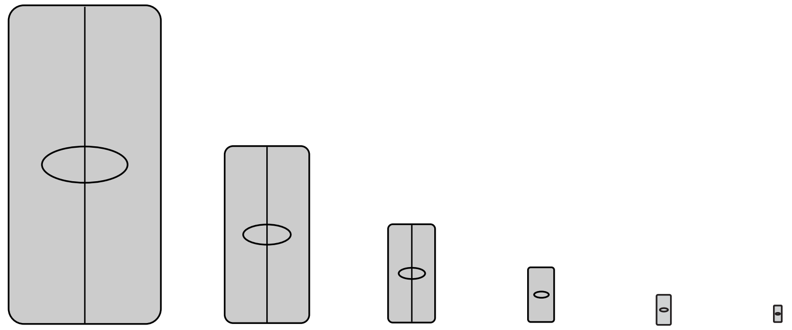
If I continue the pattern for the exponents to the next smaller power of 10, what would it be? *(10^0)*

Which block represents the next smaller block in the pattern? *(the single block)*

Extend the powers of 10 and explain as follows:

$1 = 10^0$	**The blocks have not been packed.**
$0.1 = 10^{-1}$	**We can visualize <u>unpacking</u> the blocks once to get tenth blocks.**
$0.01 = 10^{-2}$	**We can visualize <u>unpacking</u> the blocks twice to get hundredth blocks.**
And so on. (See figure on next page.)	





- Finally, have students use expanded notation and powers of 10 to describe the place value of a number, and vice versa. For example:

Write this number in expanded notation: 3,002.4

= 3 blocks-of-1000, 2 singles, 4 tenth blocks

= 3000 + 2 + 0.4

= (3 thousands) + (2 ones) + (4 tenths)

= $(3 \times 1000) + (2 \times 1) + (4 \times 0.1)$

Answer = $(3 \times 10^3) + (2 \times 10^0) + (4 \times 10^{-1})$

Write the number for: $(2 \times 10^4) + (6 \times 10^2) + (5 \times 10^0) + (7 \times 10^{-2})$

Answer = 20,605.07

◆ Group Activity 20 MIN.

- Distribute the activity sheet, *Exponents and Powers of 10*. Have students complete the activity sheet using their understanding of the way the blocks pack and unpack. They may choose to model the problems with blocks.

◆ Closure 10 MIN.

- Review the problems on the activity sheet. Have students explain their way of thinking about powers of 10 in terms of exponents.
- Write $10^0 = 1$ on the board. Ask students to respond in writing why this does or does not make sense to them. Discuss.
- Have students discuss the meaning of this statement:

  10^N is represented by a block that has been packed N times.

◆ Assessment

- Do students use exponents to correctly describe repeated factors of the same number? Can they rewrite repeated multiplication problems with exponents correctly?
- Do students identify powers of 10 in terms of exponents correctly?
- Can students explain why $10^2 = 100$? Why $10^1=10$?
- Can students explain why $10^0 = 1$? Why $10^{-1} = 0.1$?
- Can students use exponents and expanded notation to describe multi-digit numbers, and vice versa?

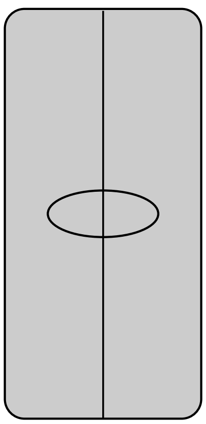
Name ....

Exponents and Powers of 10

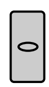
1. Use exponents to rewrite the problem:

$3 \times 7 \times 7 \times 3 \times 3 \times 5 \times 3 =$ ____________________________

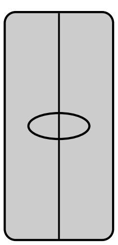
2. Write each number as a power of 10.



1000 = ______________

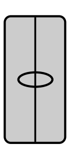


1 = ______________



100 = ______________

0.1 = ______________



10 = ______________

0.01 = ______________

Name

Exponents and Powers of 10

3. Use expanded notation with powers of 10 to describe each of these numbers.

example: $489.23 = (4 \times 10^2) + (8 \times 10^1) + (9 \times 10^0) + (2 \times 10^{-1}) + (3 \times 10^{-2})$

36, 214.82 = ____________________

5,006.07 = ____________________

11.504 = ____________________

4. Write the numbers.

$(7 \times 10^4) + (3 \times 10^0) + (3 \times 10^{-2}) =$ ____________________

$(9 \times 10^1) + (4 \times 10^{-1}) + (6 \times 10^{-3}) =$ ____________________

$(1 \times 10^2) + (1 \times 10^0) + (4 \times 10^{-5}) =$ ____________________