Warm UP

Workbook Pg. 59 Explore 1.

Do this step by step

A-F

MCC8.EE.1

1 EXPLORE Using Patterns of Integer Exponents

The table below shows powers of 5, 4, and 3.

$5^4 = 625$	$5^3 = 125$	$5^2 = 25$	$5^1 = 5$	$5^0 = 1$	$5^{-1} = \frac{1}{5}$	$5^{-2} = \frac{1}{25}$
$4^4 = 256$	$4^3 = 64$	$4^2 = 16$	$4^1 = 4$	$4^0 = 1$	$4^{-1} = \frac{1}{4}$	$4^{-2} = \frac{1}{16}$
$3^4 = 81$	$3^3 = 27$	$3^2 = 9$	$3^1 = 3$	$3^0 = 1$	$3^{-1} = \frac{1}{3}$	$3^{-2} = \frac{1}{9}$

A What pattern do you see in the powers of 5?

You are dividing by 5 each time.

B What pattern do you see in the powers of 4?

You are dividing by 4 each time

C Complete the table for the values of 5^0, 5^{-1}, 5^{-2}.

D Complete the table for the values of 4^0, 4^{-1}, 4^{-2}.

Integer Exponents

Pre-requ.

Evaluate.

1. 10^3 1000

2. 10^1 1

3. 10^4 10,000

4. 10^5 100,000

5. 10^6 1,000,000

Integer Exponents

Essential Question:
How do you evaluate expressions containing exponents, specifically negative exponents?

Standard:
MCC8.EE.1: Know and apply the properties of integer exponents to generate equivalent numerical expressions.

Integer Exponents

10^2	10^1	10^0	10^{-1}	10^{-2}
$10 \cdot 10$	10	1	$\frac{1}{10}$	$\frac{1}{10 \cdot 10}$
100	10	1	$\frac{1}{10} = 0.1$	$\frac{1}{100} = 0.01$

÷ 10 ÷ 10 ÷ 10 ÷ 10

Look for a pattern in the table to extend what you know about exponents to include negative exponents.

Additional Example 1: Using a Pattern to Simplify Negative Exponents

Simplify. Write in decimal form.

A. 10^{-2}

$$10^{-2} = \frac{1}{10 \cdot 10}$$

Extend the pattern from the table.

$$= \frac{1}{100} = 0.01$$

Multiply. Write as a decimal.

B. 10^{-1}

$$= \frac{1}{10}$$

Extend the pattern from the table.

$$= \frac{1}{10} = 0.1$$

Multiply. Write as a decimal.

Check It Out: Example 1A

Simplify. Write in decimal form.

10^{-8}

Extend the pattern from the table.

$$= \frac{1}{10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10}$$

Multiply.

$$= \frac{1}{100{,}000{,}000}$$

Write as a decimal.

$$= 0.00000001$$

Check It Out: Example 1B

10^{-9}

Extend the pattern from example 1A.

$$= \frac{1}{10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10}$$

Multiply.

$$= \frac{1}{1{,}000{,}000{,}000}$$

Write as a decimal.

$$= 0.000000001$$

Integer Exponents

NEGATIVE EXPONENTS		
Words	**Numbers**	**Algebra**
Any nonzero number raised to a negative power equals 1 divided by that number raised to the opposite (positive) power.	$5^{-3} = \frac{1}{5^3} = \frac{1}{125}$	$b^{-n} = \frac{1}{b^n}$, if $b \neq 0$

Integer Exponents

THE ZERO POWER		
Words	**Numbers**	**Algebra**
The zero power of any number except 0 equals 1.	$100^0 = 1$ $(-7)^0 = 1$	$a^0 = 1$, if $a \neq 0$

F **Conjecture** Write a general rule for the values of a^0 and a^{-n} based on the patterns in the table.

TRY THIS!

Find the value of each power.

1a. 6^{-4} **1b.** 12^0 **1c.** 8^{-1} **1d.** 7^{-3}

1e. 347^0 **1f.** 15^{-2} **1g.** 20^2 **1h.** 6^{-5}

Check It Out: Example 2A

Simplify.

4^{-2}

$\left(\frac{1}{4}\right)^2$ *Write the reciprocal; change the sign of the exponent.*

$\frac{1}{4 \cdot 4}$ *Find the product of two $\frac{1}{4}$'s.*

$\frac{1}{16}$ *Simplify.*

Additional Example 2A: Evaluating Negative Exponents

Simplify.

5^{-3}

$\frac{1}{5^3}$ *Write the power under 1; change the sign of the exponent.*

$\frac{1}{5 \cdot 5 \cdot 5}$ *Find the product of three $\frac{1}{5}$'s.*

$\frac{1}{125}$ *Simplify.*

Additional Example 2B: Evaluating Negative Exponents

Simplify.

$(-10)^{-3}$

$\left(\frac{1}{-10}\right)^3$ *Write the power under 1; change the sign of the exponent.*

$\frac{1}{-10 \cdot -10 \cdot -10}$ *Find the product of three $\frac{1}{-10}$'s.*

$\frac{1}{-1000} = -0.001$ *Simplify.*

Check It Out: Example 2B

Simplfy.

$(-7)^{-4}$

$\left(\frac{1}{-7}\right)^4$ *Write the reciprocal; change the sign of the exponent.*

$\frac{1}{-7 \bullet -7 \bullet -7 \bullet -7}$ *Find the product of four $\frac{1}{-7}$'s.*

$\frac{1}{2401}$ *Simplify.*

Integer Exponents

If the negative sign is outside, leave it outside. If it is inside () it stays inside.

Sign Outside

-2^4

$-(2 \times 2 \times 2 \times 2) = -(16) = -16$

If the negative sign is outside, you leave it outside and complete the exponent. Then bring the negative along.

Remember the understood 1. This is like $-1(2^4)$

Sign Inside

$(-2)^4$

$(-2 \times -2 \times -2 \times -2) = 16$

If the negative is inside (), then this is -2 multiplied by itself 4 times.

Integer Exponents

If the negative sign is outside, leave it outside. If it is inside () it stays inside.

$(-10)^{-3}$

$$\left(\frac{1}{-10}\right)^3$$

$$\frac{1}{(-10 \bullet -10 \bullet -10)}$$

$$\frac{1}{-1000} = -0.001$$

-10^{-3}

$$-\left(\frac{1}{10}\right)^3$$

$$\frac{1}{-(10 \bullet 10 \bullet 10)}$$

$$\frac{1}{-(1000)} = -0.001$$

Additional Example 3: Using the Order of Operations

Evaluate $5 - (6 - 4)^{-3} + (-2)^0$.

$5 - (6 - 4)^{-3} + (-2)^0$

$= 5 - (2)^{-3} + (-2)^0$ *Subtract inside the parentheses.*

$= 5 - \frac{1}{8} + 1$ *Evaluate the exponents.*

$= 5\frac{7}{8}$ *Add and subtract from left to right.*

Check It Out: Example 3

Evaluate $3 + (7 - 4)^{-2} + (-8)^0$.

$3 + (7 - 4)^{-2} + (-8)^0$

$= 3 + (3)^{-2} + (-8)^0$ *Subtract inside the parentheses.*

$= 3 + \frac{1}{9} + 1$ *Evaluate the exponents.*

$= 4\frac{1}{9}$ *Add.*

WB:
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15. $10 - (3 + 2)^0 + 2^{-1}$

16. $15 + 6^0 + 3^{-2}$

17. $6(8 - 2)^0 + 4^{-2}$

18. $2^{-2} + 4^{-1}$

19. $3(1 + 2)^{-2} + 9^{-1} + 12^0$

20. $9^0 + 64(3 + 5)^{-2}$

21. One milliliter equals 10^{-3} liter. Simplify 10^{-3}.

22. The volume of a cube is 10^6 cubic feet. Simplify 10^6.

Integer Exponents

Class work/Homework:

Text book pg. 62 13-24