


Explore It!

Calvin and Mike do sit-ups when they work out. They start with 64 sit-ups for the first set and do half as many each subsequent set.



Look for Relationships Determine whether the relationship shown for Set 1 is also true for Sets 2-5.

A. What representation can you use to show the relationship between the set number and the number of sit-ups?

B. What conclusion can you make about the relationship between the number of sit-ups in each set?

Lesson 2-7

More Properties of Integer Exponents

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I can...
write a number with a negative or zero exponent a different way.

Focus on math practices

Use Structure How could you determine the number of sit-up sets Calvin and Mike do?

123


Essential Question

What do the Zero Exponent and Negative Exponent Properties mean?

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EXAMPLE 1 The Zero Exponent Property

Marchella is playing a card-matching game with some classmates. Four matches have been made. It is Marchella's turn, and she chooses 3^0 . What card would complete her match?



Organize the information in a table and look for a pattern.

| Exponent Form | Simplified Form |
|---------------|-----------------|
| 3^4 | 81 |
| 3^3 | 27 |
| 3^2 | 9 |
| 3^1 | 3 |
| 3^0 | ? |

As the exponent decreases by one, the product is divided by 3.
 $3 \div 3 = 1$, so $3^0 = 1$.

ANOTHER WAY Use the Quotient of Powers Property.

$$3^3 \div 3^3 = 3^{3-3} = 3^0 = 1$$

When dividing two exponential expressions with the same base, subtract the exponents.

and

$$\frac{3^3}{3^3} = \frac{3 \times 3 \times 3}{3 \times 3 \times 3} = 1$$

so $3^0 = 1$

The Zero Exponent Property states that $a^0 = 1$ (assuming $a \neq 0$).

Try It!

Evaluate.

a. $(-7)^0$ b. $(43)^0$ c. 1^0 d. $(0.5)^0$

Convince Me! Why is $2(7^0) = 2$?

124 2-7 More Properties of Integer Exponents

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EXAMPLE 2 The Negative Exponent Property

Simplify the expression $4^3 \div 4^5$.

$$4^3 \div 4^5 = \frac{4^3}{4^5}$$

Remember, $\frac{a}{a} = 1$.

$$= \frac{4 \times 4 \times 4}{4 \times 4 \times 4 \times 4 \times 4} = \frac{1}{16}$$

and

$$4^3 \div 4^5 = 4^{(3-5)} = 4^{-2}$$

Use the Quotient of Powers Property.

$$\text{So, } 4^{-2} = \frac{1}{16}$$

The Negative Exponent Property states that $a^{-n} = \frac{1}{a^n}$ (assuming $a \neq 0$).

Try It!

Write each expression using positive exponents.

- a. 8^{-2} b. 2^{-4} c. 3^{-5}

EXAMPLE 3 Expressions with Negative Exponents

Write the expression $\frac{1}{7^{-3}}$ with a positive exponent.

$$\frac{1}{7^{-3}} = \frac{1}{\frac{1}{7^3}}$$

Use the Negative Exponent Property.

$$= 1 \cdot \frac{7^3}{1}$$

Multiply by the reciprocal of the denominator.

$$= 7^3$$

Try It!

Write each expression using positive exponents.

- a. $\frac{1}{5^{-3}}$ b. $\frac{1}{2^{-4}}$

KEY CONCEPT

Use these additional properties when simplifying or generating equivalent expressions with exponents (when $a \neq 0$ and $n \neq 0$).

Zero Exponent Property

$$a^0 = 1$$

Negative Exponent Property

$$a^{-n} = \frac{1}{a^n}$$

$\frac{5^{-3}}{1} = \frac{1}{5^3} = \frac{1}{125}$

negative exponent does NOT mean negative answer

Do You Understand?

1. **Essential Question** What do the Zero Exponent and Negative Exponent Properties mean?

2. **Reasoning** In the expression 9^{-12} , what does the negative exponent mean?

3. **Reasoning** In the expression $3(2^0)$, what is the order of operations? Explain how you would evaluate the expression.

Do You Know How?

4. Simplify $1,999,999^0$.

5. a. Write 7^{-6} using a positive exponent.

$\frac{1}{7^6}$

b. Rewrite $\frac{1}{10^{-3}}$ using a positive exponent.

$\frac{10^3}{1} = 10^3$

6. Evaluate $27x^0y^{-2}$ for $x = 4$ and $y = 3$.

$27 \cdot (4)^0 \cdot (3)^{-2}$

$27 \cdot 1 \cdot \frac{1}{3^2}$

$\frac{27 \cdot 1}{3^2}$

$\frac{27}{9}$

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Practice & Problem Solving

Leveled Practice In 7–8, complete each table to find the value of a nonzero number raised to the power of 0.

7.

| Exponent | Simplified |
|----------|------------|
| 4^4 | 256 |
| 4^3 | 64 |
| 4^2 | 16 |
| 4^1 | 4 |
| 4^0 | 1 |

Handwritten notes: $1 \cdot 4 \cdot 4 \cdot 4 \cdot 4$
 $1 \cdot 4 \cdot 4 \cdot 4$
 $1 \cdot 4 \cdot 4$
 $1 \cdot 4$
 1

8.

| Exponent | Simplified |
|----------|------------|
| $(-2)^4$ | 16 |
| $(-2)^3$ | |
| $(-2)^2$ | |
| $(-2)^1$ | |
| $(-2)^0$ | |

9. Given: $(-3.2)^0$
- Simplify the given expression.
 - Write two expressions equivalent to the given expression. Explain why the three expressions are equivalent.

10. Simplify each expression for $x = 6$.
- $12x^0(x^{-2})$
 - $14(x^{-2})$

In 11 and 12, compare the values using $>$, $<$, or $=$.

11. 3^{-2} 1 *see notes*

12. $(\frac{1}{4})^0$ 1

In 13 and 14, rewrite each expression using a positive exponent.

13. 9^{-4}

14. $\frac{1}{2^{-3}}$

15. Given: $9y^0$

- Simplify the expression for $y = 3$.
- Construct Arguments** Will the value of the given expression vary depending on y ? Explain.

11. $3^{-2} < 1$

$$\frac{3^{-2}}{1} = \frac{1}{3^2} = \frac{1}{9} = 0.111\dots < 1$$

$$\frac{8}{9} = 0.888\dots$$

$$\frac{73}{99} = 0.7373\dots$$

$$\frac{217}{999} = 0.217217\dots$$

$$\frac{3}{9} = 0.333\dots$$

$$\frac{1}{3}$$

$$\frac{72 \div 9}{99 \div 9} = \frac{8}{11} = 0.7272\dots$$

$$\frac{8 \cdot 9}{11 \cdot 9}$$

16. Simplify each expression for $x = 4$.

a. $-5x^{-4}$

b. $7x^{-3}$

17. Evaluate each pair of expressions.

a. $(-3)^8$ and -3^8

b. $(-3)^9$ and -3^9

18. **Be Precise** To win a math game, Lamar has to pick a card with an expression that has a value greater than 1. The card Lamar chooses reads $(\frac{1}{2})^{-4}$. Does Lamar win the game? Explain.



19. Simplify the expression. Assume that x is nonzero. Your answer should have only positive exponents.
 $x^{-10} \cdot x^6$

20. **Higher Order Thinking**

a. Is the value of the expression $(\frac{1}{4})^{-2}$ greater than 1, equal to 1, or less than 1?

b. If the value of the expression is greater than 1, show how you can change one sign to make the value less than 1. If the value is less than 1, show how you can change one sign to make the value greater than 1. If the value is equal to 1, show how you can make one change to make the value not equal to 1.

Assessment Practice

21. Rewrite 5^{-3} using a positive exponent.

22. Which expressions have values less than 1 when $x = 4$? Select all that apply.

- $(\frac{3}{4})^0$
- x^0
- $\frac{1}{6^{-1}}$
- $\frac{1}{x^{-3}}$
- $3x^{-4}$

16. Simplify each expression for $x = 4$.

a. $-5x^{-4}$

b. $7x^{-3}$

a)
$$\frac{-5(4)^{-4}}{1} = \frac{-5}{4^4} = \frac{-5}{256}$$

$$\frac{4^{-4}}{1} = \frac{1}{4^4}$$

b)
$$\frac{7 \cdot (4)^{-3}}{1} = \frac{7}{4^3} = \frac{7}{64}$$

$$\frac{4^{-3}}{1} = \frac{1}{4^3}$$

17. Evaluate each pair of expressions.

a. $(-3)^{-8}$ and -3^{-8}

b. $(-3)^{-9}$ and -3^{-9}

similar problem

a) $(-3)^{-2}$ and -3^{-2}

$$\frac{1}{(-3)^2}$$

$$\frac{1}{(-3)(-3)}$$

$$+\frac{1}{9}$$

$$\frac{-1}{3^2}$$

$$-\frac{1}{9}$$

b) $(-3)^{-3}$ and -3^{-3}

$$\frac{1}{(-3)^3}$$

$$\frac{1}{(-3)(-3)(-3)}$$

$$-\frac{1}{27}$$

$$=$$

$$\frac{-1}{(3)(3)(3)}$$

$$-\frac{1}{27}$$

