7-1 Integer Exponents

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Warm Up

Evaluate each expression for the given values of the variables.

1. x^3y^2 for $x = -1$ and $y = 10$ -100

2. $\frac{3x^2}{y^2}$ for $x = 4$ and $y = (-7)$ $\frac{48}{49}$

Write each number as a power of the given base.

3. 64; base 4 4^3

4. −27; base (−3) $(-3)^3$

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Objectives

Evaluate expressions containing zero and integer exponents.

Simplify expressions containing zero and integer exponents.

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You have seen positive exponents. Recall that to simplify 3^2, use 3 as a factor 2 times: $3^2 = 3 \cdot 3 = 9$.

But what does it mean for an exponent to be negative or 0? You can use a table and look for a pattern to figure it out.

Power	5^5	5^4	5^3	5^2	5^1	5^0	5^{-1}	5^{-2}
Value	3125	625	125	25	5	1	$\frac{1}{5}$	$\frac{1}{25}$

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Remember!

Base → x^4 ← Exponent

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

Integer Exponents

WORDS	NUMBERS	ALGEBRA
Zero exponent—Any nonzero number raised to the zero power is 1.	$3^0 = 1$ $123^0 = 1$ $(-16)^0 = 1$ $\left(\frac{3}{7}\right)^0 = 1$	If $x \neq 0$, then $x^0 = 1$.
Negative exponent—A nonzero number raised to a negative exponent is equal to 1 divided by that number raised to the opposite (positive) exponent.	$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$ $2^{-4} = \frac{1}{2^4} = \frac{1}{16}$	If $x \neq 0$ and n is an integer, then $x^{-n} = \frac{1}{x^n}$.

$\frac{1}{3^2} = \frac{1}{9}$

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Reading Math

2^{-4} is read "2 to the negative fourth power."

Anytime you see a negative exponent, it is trying to tell you to move the base to a different location. Change from top to bottom or vice versa.

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Example 1: *Application*

$2^{-4} = \frac{1}{2^4}$

$$= \frac{1}{2 \cdot 2 \cdot 2 \cdot 2}$$

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Example 2: Zero and Negative Exponents

Simplify.

A. 4^{-3}

$$4^{-3} = \frac{1}{4^3} = \frac{1}{4 \cdot 4 \cdot 4} = \frac{1}{64}$$

B. 7^0

$$7^0 = 1$$

C. $(-5)^{-4}$

$$= \frac{1}{(-5)^4} = \frac{1}{(-5)(-5)(-5)(-5)} = \frac{1}{625}$$

D. -5^{-4}

$$= -\frac{1}{5^4} = -\frac{1}{5 \cdot 5 \cdot 5 \cdot 5} = -\frac{1}{625}$$

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Caution

In $(-3)^{-4}$, the base is negative because the negative sign is inside the parentheses. In -3^{-4} the base (3) is positive.

If the negative sign is in the parenthesis if moves with the base.

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Example 3A: Evaluating Expressions with Zero and Negative Exponents

Evaluate the expression for the given value of the variables.

x^{-2} **for** $x = 4$

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

$$\frac{x^{-2}}{1} = \frac{1}{x^2}$$

$$\frac{1}{4^2} = \frac{1}{(4)^2} = \frac{1}{16}$$

Use the definition $x^{-n} = \frac{1}{x^n}$.

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Example 3B: Evaluating Expressions with Zero and Negative Exponents

Simplify the expression for the given values of the variables.

$-2a^0b^{-4}$ **for** ~~$a = 5$~~ **and** $b = -3$

$$-2\,a^0\,b^{-4} = \frac{-2}{b^4} = \frac{-2}{(-3)^4} = \frac{-2}{81}$$

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Example 4: Simplifying Expressions with Zero and Negative Numbers

Simplify.

c. $\frac{a^0 b^{-2}}{c^{-3} d^6} = \frac{c^3}{b^2 d^6}$

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Check It Out! Example 4

Simplify.

5. $\frac{8}{a^{-3}} = 8a^3$

6. $9x^3y^{-2} = \frac{9x^3}{y^2}$

8. $\frac{b^2}{a^{-1}b^3} = \frac{ab^2}{b^3} \frac{a}{b}$ $\frac{a \cdot b \cdot b}{b \cdot b \cdot b}$

9. $5x^{-4}y^2$ $\frac{5y^2}{x^4}$

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13. $-a^3b^{-4}$ for $a = 2$ and $b = -1$

$\frac{-a^3}{b^4}$ $\frac{-2^3}{(-1)^4}$ $\frac{-8}{1} = -8$

14. $\frac{n^{-2}}{m^{-4}}$ for $m = 6$ and $n = 2$

$\frac{m^4}{n^2}$ $\left(\frac{n^2}{m^4}\right)^{-1}$ $\left(\frac{a^2b^3}{3cd^4}\right)^{-1}$ $\frac{3cd^4}{a^2b^3}$

1) 4^0

1

2) 4^{-2}

$\frac{1}{16}$

3) $4n^{-3}$ $\frac{4}{n^3}$

4) $2r^{-1}$ $\frac{2}{r}$

5) $3m^{-4}$ $\frac{3}{m^4}$

6) $\frac{4u^{-2}v^{0}}{v^{-2}} = \frac{4v^2}{u^2}$

7) $\frac{3mn^{-2}}{m^{0}}$ $\frac{3m}{n^2}$

8) $2zx^{-2}y^{0}$ $\frac{2z}{x^2}$

9) $3zx^{-2}y^{-2}$ $\frac{3z}{(xy)^2}$

10) $2qp^{-4}r^{2}$ $\frac{2qr^2}{p^4}$

11) $x^{-1}y^{4}z^{0}$

$\frac{1}{1}$

$\frac{y^4}{x}$

12) $2npm^{-3}$

$\frac{2np}{m^3}$