

Zero and Negative Exponents



Goal: Simplify expressions with negative exponents.

Definition of Zero and Negative Exponents

Let a be a nonzero number, and let n be an integer.

Words

a to the zero

power is 1 a^{-n} is the

reciprocal of

aⁿ is the

reciprocal of a-n

Algebra

$$\begin{bmatrix} a & n \end{bmatrix} = \frac{1}{a'}$$

$$\left| a^n \right| = \frac{1}{a^{-r}}$$

Example

$$6^{-4} = \frac{1}{6^4}$$

$$8^3 = \boxed{\frac{1}{8^{-3}}}$$

Using Zero and Negative Exponents

a.
$$4^0 = 1$$

Definition of zero exponent

Definition of negative exponent

Evaluate power.

Definition of negative exponent

Evaluate power.

Divide.

EXAMPLE 2 Using a Negative Exponent

Computers The speed of a computer chip is measured in nanoseconds. One nanosecond is $\frac{1}{1,000,000,000}$ second. Write one nanosecond in seconds as a power of ten.

Solution

$$\frac{1}{1,000,000,000} = \boxed{\frac{1}{10^9}} \quad \text{Write 1,000,000,000 as } \boxed{\frac{1}{10^9}}$$



10⁻⁹ Definition of negative exponent

Answer: One nanosecond is 10^{-9} second.

EXAMPLE 3 Evaluating an Algebraic Expression

Evaluate the expression $x^4 \cdot x^{-7}$ when x = 6.

$$x^4 \cdot x^{-7} = 6^4 \cdot 6^{-7} = 6^{4 + (-7)}$$

$$= \begin{bmatrix} \frac{1}{6^3} \\ \frac{1}{6^3} \end{bmatrix} = \begin{bmatrix} \frac{1}{216} \end{bmatrix}$$

Guided Practice Evaluate the expression.

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Evaluate the expression when x = 3.

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EXAMPLE 4. Simplifying Algebraic Expressions



WATCH OUT!

In an expression such as $-9x^0$ or $-3a^{-4}$, the exponent is applied only to the variable, not to the coefficient.

a.
$$-9x^0 = -9 \cdot \boxed{x^0}$$

= $-9 \cdot \boxed{4}$

Definition of zero exponent

Multiply.

b.
$$-3a^{-4} = -3 \cdot \boxed{a^{-4}}$$

Exponent applies only to a.

Zero exponent applies only to x.

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

Definition of negative exponent

$$=\begin{bmatrix} -3 \\ a^4 \end{bmatrix}$$

Multiply.

$$\mathbf{c.} \ \frac{10t^{-3}}{t^2} = \frac{10 \cdot t^{-3}}{t^2}$$
$$= 10 \cdot t^{-3}$$
$$= 10 \cdot t^{-3}$$

Exponent applies only to t.

Quotient of powers property

Simplify.

Definition of negative exponent

Homework

Guided Practice Simplify the algebraic expression.

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