Lesson 8-1 P. 135 WKbK

Zero and Negative Exponents

Lesson Objectives
- Simplify expressions with zero and negative exponents
- Evaluate exponential expressions

NAEP 2005 Strand: Number Properties and Operations
Topics: Number Sense; Properties of Number and Operations
Local Standards: _____

$2^4 = 16$

$2^3 = 2 \cdot 2 \cdot 2 = 8$

$2^2 = 2 \cdot 2 = 4$

$2^1 = 2$

$2^0 = 1$

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

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

$2^{-3} = \frac{1}{8}$

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

$2^{-3} = \frac{1}{2^3} = \frac{1}{8}$

Key Concepts

Zero as an Exponent
For every nonzero number a, $a^0 = 1$
Examples $5^0 = 1$ $(-2)^0 = 1$ $(1.02)^0 = 1$ $\left(\frac{1}{3}\right)^0 = 1$ $-2^0 = -1$

Negative Exponent $(-2)^0 = 1$
For every nonzero number a and integer n, $a^{-n} = \frac{1}{a^n}$
Examples $6^{-4} = \frac{1}{6^4}$ $(-8)^{-1} = \frac{1}{(-8)^1}$

$6^{-4} = \frac{1}{6^4} = \frac{1}{6 \cdot 6 \cdot 6} = \frac{1}{1296}$

$(-8)^{-1} = \frac{1}{(-8)^1} = \frac{1}{-8}$

Examples

1 Simplifying a Power Simplify:

a. $3^{-2} = \frac{1}{3^2}$ Use the definition of negative exponent.

$= \frac{1}{9}$ Simplify.

b. $(-22.4)^0 = 1$ Use the definition of zero as an exponent.

2 Simplifying an Exponential Expression Simplify each expression.

$\frac{1}{x^{-3}} =$ Rewrite using a division symbol.

$= 1 \div \frac{1}{x^3}$ Use the definition of negative exponent.

$= 1 \cdot x^3$ Multiply by the reciprocal of $\frac{1}{x^3}$, which is x^3.

$= x^3$ Identity Property of Multiplication

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

if a negative expt is on the bottom, move to the top & make the expt positive

Quick Check

1. Simplify each expression.

a. 3^{-4} $1/81$ ✓ $\frac{1}{3^4} = \frac{1}{81}$

b. $(-7)^0$ 1 ✓

c. $(-4)^{-3}$ $-\frac{1}{64}$ ✓ $\frac{1}{(-4)^3} = \frac{1}{(-4)(-4)(-4)} = \left(\frac{1}{-64}\right)$

Example

❸ **Evaluating an Exponential Expression** Evaluate $4x^2y^{-3}$ for $x = 3$ and $y = -2$.

$4x^2y^{-3} = 4(\boxed{3})^2(\boxed{-2})^{-3}$ Substitute $\boxed{3}$ for x and $\boxed{-2}$ for y.

$= \frac{4(3)^2}{(-2)^3} = \frac{4 \cdot 9}{-8}$ Use the definition of negative exponent.

$= \frac{36}{-8} = \frac{9}{-2}$ Simplify.

$\frac{4x^2}{y^3}$ OR $-\frac{9}{2}$

$(-2)(-2)(-2)$

Quick Check

2. Simplify each expression.

a. $11m^{-5}$ $\frac{11}{m^5}$

b. $7s^{-4}t^2$ $\frac{7t^2}{s^4}$

$\frac{3x^2}{y^{-2}} = \frac{3x^2y^2}{1} = 3x^2y^2$

$\frac{x^{-6}}{z^{-7}} = \frac{z^7}{x^6}$

c. $\frac{2}{a^{-3}}$ $\frac{2a^3}{1} = 2a^3$

d. $\frac{n^{-5}}{v^2}$ $\frac{1}{n^5v^2}$ $\frac{1}{v^2n^5}$

3. Evaluate each expression for $n = -2$ and $w = 5$.

a. $n^{-3}w^0$ $\frac{1}{-8}$

$n^{-3}w^0 = \frac{1}{n^3} = \frac{1}{(-2)^3} = \frac{1}{-8}$

b. $\frac{n^{-1}}{w^2}$ $\frac{1}{n^1 w^2}$

$\frac{1}{(-2)^1(5)^2} = \frac{1}{-2(25)} = \frac{1}{-50}$

3. Evaluate each expression for $n = -2$ and $w = 5$.

c. $\frac{n^0}{n^4}$ $\frac{1}{n^4} = \frac{1}{(-2)^4} = \frac{1}{16}$

d. $\frac{1}{nw^{-2}}$ $\frac{1w^2}{n} = \frac{w^2}{n}$

$\frac{5^2}{-2} = \frac{25}{-2}$

WS 8.1 p. 389 column 1 - solo

Marker Boards WS 8.1 2nd column

4^{-2}

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

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

$4 \cdot 64$

$= 256$

$16 \cdot 2^{-2}$

$16 \cdot \frac{1}{2^2} = 16 \cdot \frac{1}{4} = 4$

$9^0 = 1$

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

$(-4.9)^0 = 1$

$-4.9^0 = -1$

Evaluate each expression for $a = -2$ and $b = 6$.

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

$2b^{-2} = \frac{2}{b^2} = \frac{2}{6^2} = \frac{2}{36} = \frac{1}{18}$

$-4a^{-2}b^{-3}$ $\quad a=-2$, $b=6$

$\frac{-4}{a^2 b^3} = \frac{-4}{(-2)^2(6)^3} = \frac{-4}{4 \cdot 216}$

$\frac{-4 \div 4}{864 \div 4} \rightarrow = -\frac{1}{216}$

$x^1 y^{-3} = \frac{x^1}{y^3} = \frac{x}{y^3}$

$\frac{1}{xy^3}$

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

$8a^{-3}b^2c^{-2} = \frac{8b^2}{a^3c^2}$

$\frac{3m^{-4}}{n^{-8}}$

Write each number as a power of 10 using a negative exponent.

$\frac{1}{1{,}000{,}000} = \frac{1}{10^6} = 10^{-6}$

$10^2 = 100$

$10^3 = 1000$

CW/HW:
WKBK p. 389
4th column
(4-72) ↓

Write each expression as a decimal.

10^{-8}

Evaluate each expression for $m = 4$, $n = 5$, and $p = -2$.

n^m

m^{-n}

$\frac{m}{n^p}$