Zero and Negative Exponents

5.5

KEY CONCEPT *For Your Notebook*

Definition of Zero and Negative Exponents

Words	Algebra	Example
a to the zero power is 1.	$a^0 = 1, a \neq 0$	$5^0 = 1$
a^{-n} is the reciprocal of a^n.	$a^{-n} = \frac{1}{a^n}, a \neq 0$	$2^{-1} = \frac{1}{2}$
a^n is the reciprocal of a^{-n}.	$a^n = \frac{1}{a^{-n}}, a \neq 0$	$2 = \frac{1}{2^{-1}}$

EXAMPLE 1 Use definition of zero and negative exponents

a. $3^{-2} = \dfrac{1}{3^2}$ **Definition of negative exponents**

$= \dfrac{1}{9}$ **Evaluate exponent.**

b. $(-7)^0 = 1$ **Definition of zero exponent**

EXAMPLE 1 Use definition of zero and negative exponents

c. $\left(\frac{1}{5}\right)^{-2} = \frac{1}{\left(\frac{1}{5}\right)^{2}}$ **Definition of negative exponents**

$= \frac{1}{\frac{1}{25}}$ **Evaluate exponent.**

$= 25$ **Simplify by multiplying numerator and denominator by** 25**.**

d. $0^{-5} = \frac{1}{0^{5}}$ **(Undefined)** a^{-n} **is defined only for a *nonzero* number** a**.**

EXAMPLE 2 Evaluate exponential expressions

a. $6^{-4} \cdot 6^{4} = 6^{-4+4}$ **Product of a power property**

$= 6^{0}$ **Add exponents.**

$= 1$ **Definition of zero exponent**

EXAMPLE 2 Evaluate exponential expressions

b. $(4^{-2})^2 = 4^{-2 \cdot 2}$ **Power of a power property**

$= 4^{-4}$ **Multiply exponents.**

$= \dfrac{1}{4^4}$ **Definition of negative exponents**

$= \dfrac{1}{256}$ **Evaluate power.**

c. $\dfrac{1}{3^{-4}} = 3^4$ **Definition of negative exponents**

$= 81$ **Evaluate power.**

EXAMPLE 2 Evaluate exponential expressions

d. $\dfrac{5^{-1}}{5^2} = 5^{-1-2}$ **Quotient of powers property**

$= 5^{-3}$ **Subtract exponents.**

$= \dfrac{1}{5^3}$ **Definition of negative exponents**

$= \dfrac{1}{125}$ **Evaluate power.**

EXAMPLE 3 Use properties of exponents

Simplify the expression. Write your answer using only positive exponents.

a. $(2xy^{-5})^3 = 2^3 \cdot x^3 \cdot (y^{-5})^3$ **Power of a product property**

$= 8 \cdot x^3 \cdot y^{-15}$ **Power of a power property**

$= \dfrac{8x^3}{y^{15}}$ **Definition of negative exponents**

EXAMPLE 3 Use properties of exponents

b. $$\frac{(2x)^{-2}y^5}{-4x^2y^2} = \frac{y^5}{(2x)^2(-4x^2y^2)}$$ **Definition of negative exponents**

$$= \frac{y^5}{4x^2(-4x^2y^2)}$$ **Power of a product property**

$$= \frac{y^5}{-16x^4y^2}$$ **Product of powers property**

$$= -\frac{y^3}{16x^4}$$ **Quotient of powers property**

GUIDED PRACTICE for Example 1

Evaluate the expression.

1. $\left(\frac{2}{3}\right)^0 = \square$

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

2. $(-8)^{-2} = \square$

4. $(-1)^0 = \square$

GUIDED PRACTICE for Example 2

Evaluate the expression.

5. $\dfrac{1}{4^{-3}} =$ ☐

7. $(-3)^{5} \cdot (-3)^{-5} =$ ☐

6. $(5^{-3})^{-1} =$ ☐

8. $\dfrac{6^{-2}}{6^{2}} =$ ☐