1 Zero and Negative Exponents

Activity: Exponents

1. a. Copy the table below. Replace each blank with the value of the power in simplest form.

2^x	5^x	10^x
$2^4 =$ ■	$5^4 =$ ■	$10^4 =$ ■
$2^3 =$ ■	$5^3 =$ ■	$10^3 =$ ■
$2^2 =$ ■	$5^2 =$ ■	$10^2 =$ ■

b. Look at the values that you used to replace the blanks. What pattern do you see as you go down each column?

2. Copy the table below. Use the pattern you described in Question 1 to complete the table.

2^x	5^x	10^x
$2^1 =$ ■	$5^1 =$ ■	$10^1 =$ ■
$2^0 =$ ■	$5^0 =$ ■	$10^0 =$ ■
$2^{-1} =$ ■	$5^{-1} =$ ■	$10^{-1} =$ ■
$2^{-2} =$ ■	$5^{-2} =$ ■	$10^{-2} =$ ■

3. **Critical Thinking** What pattern do you notice in the row with 0 as an exponent?

4. Copy and complete each expression.
a. $2^{-1} = \frac{1}{2^{■}}$ b. $2^{-2} = \frac{1}{2^{■}}$ c. $2^{-3} = \frac{1}{2^{■}}$

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Property Zero as an Exponent

For every nonzero number a, $a^0 = 1$.

Examples $5^0 = 1$ $(-2)^0 = 1$ $(1.02)^0 = 1$ $\left(\frac{1}{3}\right)^0 = 1$

Property Negative Exponent

For every nonzero number a and integer n, $a^{-n} = \frac{1}{a^n}$.

Examples $6^{-4} = \frac{1}{6^4}$ $(-8)^{-1} = \frac{1}{(-8)^1}$

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1 EXAMPLE Simplifying a Power

Simplify.

a. 4^{-3} Use the definition of negative exponent.

Simplify.

b. $(-1.23)^0$ Use the definition of zero as an exponent.

1 Simplify each expression.
a. 3^{-4} **b.** $(-7)^0$ **c.** $(-4)^{-3}$ **d.** 7^{-1} **e.** -3^{-2}

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3 EXAMPLE Evaluating an Exponential Expression

Evaluate $3m^2t^{-2}$ for $m = 2$ and $t = -3$.

Method 1 Write with positive exponents first.

$3m^2t^{-2}$

Method 2 Substitute first.

$3m^2t^{-2}$

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3 Evaluate each expression for $n = -2$ and $w = 5$.
a. $n^{-3}w^0$ **b.** $\frac{n^{-1}}{w^2}$ **c.** $\frac{w^0}{n^4}$ **d.** $\frac{1}{nw^{-2}}$

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4 EXAMPLE Real-World Problem Solving

Population Growth A biologist is studying green peach aphids, like the one shown at the left. In the lab, the population doubles every week. The expression $1000 \cdot 2^w$ models an initial population of 1000 insects after w weeks of growth.

a. Evaluate the expression for $w = 0$. Then describe what the value of the expression represents in the situation.

$1000 \cdot 2^w$

The value of the expression represents the initial population of insects. This makes sense because when $w = 0$, no time has passed.

b. Evaluate the expression for $w = -3$. Then describe what the value of the expression represents in the situation.

$1000 \cdot 2^w$

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4 A sample of bacteria triples each month. The expression $5400 \cdot 3^m$ models a population of 5400 bacteria after m months of growth. Evaluate the expression for $m = -2$ and $m = 0$. Describe what each value of the expression represents

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