

**1-5 Properties of Exponents**Lesson Objective

Simplify expressions involving exponents.

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In an expression of the form  $a^n$ ,  $a$  is the base,  $n$  is the exponent, and the quantity  $a^n$  is called a power. The exponent indicates the number of times that the base is used as a factor.

Base Exponent

$$a^n = a \cdot a \cdot a \cdot \dots \cdot a \cdot a \cdot a$$

$a$  is a factor  $n$  times

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When the base includes more than one symbol, it is written in parentheses.

Exponential Form	Base	Expanded Form
$-2x^3$	$x$	$-2(x \cdot x \cdot x)$
$-(2x)^3$	$2x$	$-(2x)(2x)(2x)$
$(-2x)^3$	$-2x$	$(-2x)(-2x)(-2x)$

**Reading Math**

A **power** includes a base and an exponent. The expression  $2^3$  is a power of 2. It is read "2 to the third power" or "2 cubed."

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Write the expressions in expanded form.

$(5z)^2$

$-s^4$

$(2a)^5$

$3b^4$

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Write the expressions in expanded form.

$3h^3(k + 3)^2$

$-(2x - 1)^3y^2$

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**Zero and Negative Exponents**

For all nonzero real numbers  $a$  and integers  $n$ ,

WORDS	NUMBERS	ALGEBRA
<b>Zero Exponent Property</b> A nonzero quantity raised to the zero power is equal to 1.	$100^0 = 1$	$a^0 = 1$
<b>Negative Exponent Property</b> A nonzero base raised to a negative exponent is equal to the reciprocal of the base raised to the opposite, positive exponent.	$7^{-2} = \left(\frac{1}{7}\right)^2 = \frac{1}{7^2}$ $\left(\frac{3}{2}\right)^{-4} = \left(\frac{2}{3}\right)^4$	$a^{-n} = \left(\frac{1}{a}\right)^n = \frac{1}{a^n}$ $\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$

**Caution!**

Do not confuse a negative exponent with a negative expression.

$$a^{-n} \neq -a^n \neq \frac{1}{-a^n}$$

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Simplify the expressions.

$3^{-2}$   $\left(\frac{2}{3}\right)^{-2}$

$(-5)^{-5}$   $\left(\frac{1}{3}\right)^{-2}$

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**Properties of Exponents**

For all nonzero real numbers  $a$  and  $b$  and integers  $m$  and  $n$ ,

WORDS	NUMBERS	ALGEBRA
<b>Product of Powers Property</b> To multiply powers with the same base, add the exponents.	$4^3 \cdot 4^2 = 4^{3+2} = 4^5$	$a^m \cdot a^n = a^{m+n}$
<b>Quotient of Powers Property</b> To divide powers with the same base, subtract the exponents.	$\frac{3^7}{3^2} = 3^{7-2} = 3^5$	$\frac{a^m}{a^n} = a^{m-n}$
<b>Power of a Power Property</b> To raise one power to another, multiply the exponents.	$(4^3)^2 = 4^{3 \cdot 2} = 4^6$	$(a^m)^n = a^{m \cdot n}$
<b>Power of a Product Property</b> To find the power of a product, apply the exponent to each factor.	$(3 \cdot 4)^2 = 3^2 \cdot 4^2$	$(ab)^m = a^m b^m$
<b>Power of a Quotient Property</b> To find the power of a quotient, apply the exponent to the numerator and denominator.	$\left(\frac{3}{5}\right)^2 = \frac{3^2}{5^2}$	$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$

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Simplify the expressions. Assume all variables are nonzero.

$3z^7(-4z^2)$   $\left(\frac{yz^3}{z^5}\right)^3$

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Simplify the expressions. Assume all variables are nonzero.

$(5x^6)^3$   $(-2a^3b)^{-3}$

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