5.1 Integer Exponents & Scientific Notation

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Objectives:

- Use the product rule for exponents.
- Define 0 and negative exponents.
- Use the quotient rule for exponents.
- Use the power rules for exponents.
- Simplify exponential expressions.
- Use the rules for exponents with scientific notation.

Product Rule for Exponents

Consider:

$$2^5 \cdot 2^3 =$$

$$x^4 \cdot x^7 =$$

Product Rule for Exponents

If m and n are natural numbers and a is any real number, then

When multiplying like bases, keep the base and add the exponents.

Apply the produce rule, if possible, in each case.

a)
$$m^8 \cdot m^6$$
 b) $(-5y^4)(-9y^5)$

c) $m^5 \cdot p^4$ d) $(-3x^2y^3)(7xy^4)$



Consider:

$$4^2 \cdot 4^0 =$$

Zero Exponent

If a is any nonzero real number, then

Any non-zero base raised to the power of 0 equals 1.

*The expression 0⁰ is undefined.



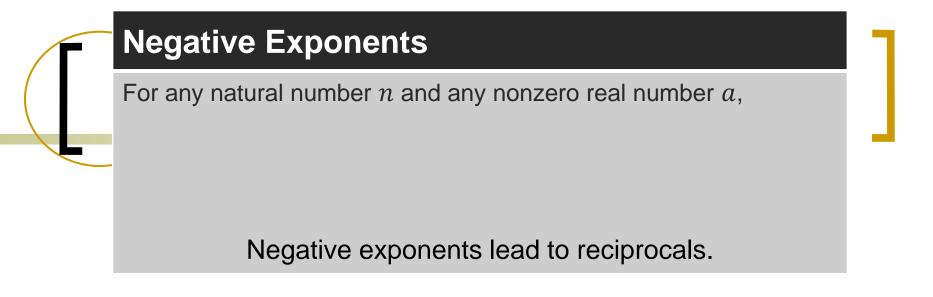
Evaluate.

c)
$$(-5x)^0$$
 d) $10^0 - 9^0$



Consider:

$$8^2 \cdot 8^{-2} =$$



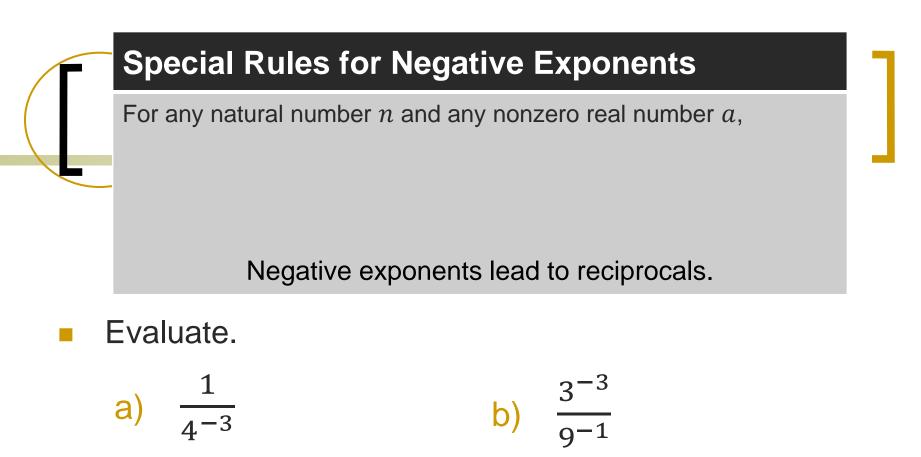
Write with only positive exponents:

a)
$$6^{-5}$$
 b) $-7p^{-4}$

Write with only positive exponents.

a)
$$(5z)^{-3}$$
 b) $5z^{-3}$

c)
$$(2x)^{-4}$$
 d) $4^{-1} - 2^{-1}$



Quotient Rule for Exponents

Consider:

 $\frac{a^8}{a^3}$

Quotient Rule for Exponents

If a is any nonzero real number and m and n are integers, then

When dividing like bases – keep the base and subtract the exponents. (top exponent – bottom exponent)

Write with only positive exponents.

a)
$$\frac{x^7}{x^2}$$
 b) $\frac{5^{-6}}{5^{-8}}$

c) $\frac{m^8}{m^{13}}$

d)
$$\frac{x^3}{y^5}$$

Power Rule for Exponents

Consider:

 $(3^4)^2 =$

 $(xy)^4 =$

 $\left(\frac{2}{2}\right)$



Power Rules for Exponents

If a and b are real numbers and m and n are integers, then

To raise a power to a power, multiply the exponents.

To raise a product to a power, raise each factor to that power.

To raise a quotient to a power, raise the numerator and denominator to that power.

Simplify using the power rules.

a)
$$(r^5)^4$$
 b) $\left(\frac{3}{4}\right)^3$

c)
$$(-3y^5)^2$$
 d) $\left(-\frac{2m^5}{z}\right)^3$



Special Rules for Negative Exponents (Continued)

If $a \neq 0$ and $b \neq 0$ and n is an integer, then

Any non-zero number raised to the negative nth power is equal to the reciprocal of that number raised to the nth power.

Write with only positive exponents then evaluate.

a)
$$\left(\frac{2}{3}\right)^{-4}$$
 b) $\left(\frac{4x}{5}\right)^{-3}$

Simplify each exponential expression so that no negative exponents appear in the final answer.

b

a)
$$x^{-4} \cdot x^{-6} \cdot x^{8}$$

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

 Simplify each exponential expression so that no negative exponents appear in the final answer.

a)
$$\left(\frac{3x^2}{y}\right)^2 \left(\frac{4x^3}{y^{-2}}\right)^{-1}$$
 b) $\left(-\frac{4m^5n^4}{24mn^{-7}}\right)^{-2}$

Scientific Notation

Numbers occurring in science are often extremely large (such as the distance from Earth to the Sun, 93,000,000 miles) or extremely small (the wavelength of yellow-green light, approximately 0.0000006 m.) Because of the difficulty of working with many zeros, scientists often express such numbers with exponents, using a form called scientific notation.

Scientific Notation

A number is written in **scientific notation** when it is expressed in the form

Scientific Notation

Using your calculator (or cell phone) find:

 $5,000,000 \times 6,000,000,000,000$

- Numbers in scientific notation with ______.

Write each number in scientific notation.

a) 0.0571 b) -2,140,000,000

c) 843 d) 0.000062

Write each number in standard notation.

a) 2.51×10^3 b) -6.8×10^{-4}

c) -5.7×10^{-2} d) 1.083×10^{0}

Evaluate. Write answers in scientific notation and in standard notation.

a)
$$(3 \times 10^5)(5 \times 10^{-2})$$

b) $\frac{4.8 \times 10^2}{2.4 \times 10^5}$

 Evaluate. Write answers in scientific notation and in standard notation.

 $1,920,000 \times 0.0015$

 $0.000032 \times 45,000$



If the speed of light is approximately 3.0×10^5 km/sec, how many seconds does it take light to travel approximately 1.5×10^8 km from the Sun to the Earth?