7-2 Powers of 10 and Scientific Notation

Warm Up

Evaluate each expression.

1. $123 \times 1{,}000$ 123,000
2. $123 \div 1{,}000$ 0.123
3. 0.003×100 0.3
4. $0.003 \div 100$ 0.00003
5. 10^4 10,000
6. 10^{-4} 0.0001
7. 23^0 1

Objectives

Evaluate and multiply by powers of 10.

Convert between standard notation and scientific notation.

Vocabulary

scientific notation

Powers of 10

WORDS	NUMBERS
Positive Integer Exponent	
If n is a positive integer, find the value of 10^n by starting with 1 and moving the decimal point n places to the right.	$10^4 = 1\,0,\,0\,0\,0$ (4 places)
Negative Integer Exponent	
If n is a positive integer, find the value of 10^{-n} by starting with 1 and moving the decimal point n places to the left.	$10^{-6} = \frac{1}{10^6} = 0.0\,0\,0\,0\,0\,1$ (6 places)

Example 1: Evaluating Powers of 10

Find the value of each power of 10.

A. 10^{-6} **B. 10^{4}** **C. 10^{9}**

1.
.000001

10000

1,000,000,000

When converting Stand Form into Scientific Notation ask yourself is the original number larger or smaller than the base of the Scientific Notation.

- If the base is greater the stand number the exponent will negative
- If the base is less than the stand number the exponent will be positive.

1.25 x 10

1.250

Example 2: Writing Powers of 10

Write each number as a power of 10.

A. 1,000,000 **B. 0.0001** **C. 1,000**

10^{6}

10^{-4}

10^{3}

Scientific notation is a method of writing numbers that are very large or very small. A number written in scientific notation has two parts that are multiplied.

The first part is a number that is greater than or equal to 1 and less than 10.

In other words pick a # 1 to 10 just not 10.

3.5×10^{11} 9.98×10^{-2}

.0998

The second part is a power of 10.

Example 4A: *Astronomy Application*

Saturn has a diameter of about 1.2×10^5 km. Its distance from the Sun is about 1,427,000,000 km.

Write Saturn's diameter in standard form.

1.2×10^5

1 2 0 0 0 0

120,000 km

Move the decimal point 5 places to the right.

Example 4B: *Astronomy Application*

Saturn has a diameter of about 1.2×10^5 km. Its distance from the Sun is about 1,427,000,000 km.

Write Saturn's distance from the Sun in scientific notation.

1,427,000,000

1.427×10^9

Reading Math

Standard form refers to the usual way that numbers are written—not in scientific notation.

Check It Out! Example 4a

Write Jupiter's diameter in scientific notation.

143,000 km

1 4 3 0 0 0

5 places

1.43×10^5 km

Count the number of places you need to move the decimal point to get a number between 1 and 10.

Use that number as the exponent of 10.

Check It Out! Example 4b

Write Jupiter's orbital speed in standard form.

$1.3 \times 10^4 \text{ m/s}$

1 3 0 0 0

Move the decimal point 4 places to the right.

13,000 m/s

Example 5: Comparing and Ordering Numbers in Scientific Notation

Order the list of numbers from least to greatest.

$1.3 \times 10^{-2}, 6.3 \times 10^3, 4.1 \times 10^6, 2.1 \times 10^6, 1 \times 10^{-2}, 5.4 \times 10^{-3}$

$5.4 \times 10^{-3}, 1 \times 10^{-2}, 1.3 \times 10^{-2}, 6.3 \times 10^3, 2.1 \times 10^6, 4.1 \times 10^6$

Objective

Use multiplication properties of exponents to evaluate and simplify expressions.

Simplifying Exponential Expressions

An exponential expression is completely simplified if...

- There are no negative exponents.
- The same base does not appear more than once in a product or quotient.
- No powers are raised to powers.
- No products are raised to powers.
- No quotients are raised to powers.
- Numerical coefficients in a quotient do not have any common factor other than 1.

Examples	Nonexamples
$\frac{b}{a}$ x^3 z^{12} a^4b^4 $\frac{s^5}{t^5}$ $\frac{5a^2}{2b}$	$a^{-2}ba$ $x \cdot x^2$ $(z^3)^4$ $(ab)^4$ $\left(\frac{s}{t}\right)^5$ $\frac{10a^2}{4b}$

Products of powers with the same base can be found by writing each power as a repeated multiplication.

$$3^5 \cdot 3^2 = (3\cdot3\cdot3\cdot3\cdot3)\cdot(3\cdot3) = 3^7$$

Notice the relationship between the exponents in the factors and the exponents in the product $5 + 2 = 7$.

Nothing
−
÷
√

Nothing
Add
Mult.
Power

Product of Powers Property

WORDS	NUMBERS	ALGEBRA
The product of two powers with the same base equals that base raised to the sum of the exponents.	$6^7 \cdot 6^4 = 6^{7+4} = 6^{11}$	If a is any nonzero real number and m and n are integers, then $a^m \cdot a^n = a^{m+n}$.

When multiplying number with the same base add their exponents.

Remember every # has an exponent.

Example 1: Finding Products of Powers

Simplify.

A. $3^2 \cdot 3^5$

$3^2 \cdot 3^5$

3^{2+5}

3^7

B. $2^4 \cdot 3^4 \cdot 2^{-2} \cdot 3^2$

$2^4 \cdot 3^4 \cdot 2^{-2} \cdot 3^2$

$(2^4 \cdot 2^{-2}) \cdot (3^4 \cdot 3^2)$

$(2^{4-2}) \cdot (3^{4+2})$

$2^2 \cdot 3^6$

C. $q^3 \cdot r^2 \cdot q^6$

$q^3 \cdot r^2 \cdot q^6$

$(q^3 \cdot q^6) \cdot r^2$

$q^9 \cdot r^2$

D. $n^3 \cdot n^{-4} \cdot n$

$n^3 \cdot n^{-4} \cdot n$

$(n^3 \cdot n^1) \cdot n^{-4}$

$n^4 \cdot n^{-4}$

1

Example 1: Finding Products of Powers

Simplify.

C. $q^3 \cdot r^2 \cdot q^6$

$q^3 \cdot r^2 \cdot q^6$

$(q^3 \cdot q^6) \cdot r^2$

$q^9 \cdot r^2$

$q^9 r^2$

Group powers with the same base together.

Add the exponents of powers with the same base.

D. $n^3 \cdot n^{-4} \cdot n$

$n^3 \cdot n^{-4} \cdot n$

$(n^3 \cdot n^1) \cdot n^{-4}$

$n^4 \cdot n^{-4}$

1

Group the positive exponents and add since they have the same base

Add the like bases.

Check It Out! Example 1

Simplify.

1. $2^3 \cdot 2^4 = 2^7$

2. $8^{-2} \cdot 5^3 \cdot 8^6$ 8^{6+-2} 5^3 $= 8^4 \cdot 5^3$

3. $2^4 \cdot 3^5 \cdot 2^8 \cdot 3^{-2}$ $2^{12} \cdot 3^3$

Check It Out! Example 2

Light travels at about 1.86×10^5 miles per second. Find the approximate distance that light travels in one hour. Write your answer in scientific notation.

1hr → sec.

1hr = 60min. = 3600sec. 3.6×10^3

186,000

3,600

$(3.6 \times 10^3)(3.86 \times 10^5)$

13.896×10^8

1.3896×10^9

Lesson Quiz: Part I

Find the value of each expression.

1. 37.45×10^5

2. 29.3×10^{-4}

3. Order the list of numbers from least to greatest

$3.6 \times 10^{-3}, 1 \times 10^{-5}, 2.7 \times 10^2, 1.3 \times 10^4, 3.1 \times 10^4,$

4.1×10^{-3}

