EXTENSION

Negative Exponents

Learn to evaluate negative exponents and use them to write numbers in scientific notation and in standard form.

When a whole number has a positive exponent, the value of the power is greater than 1. When a whole number has a negative exponent, the value of the power is less than 1. When any number has a zero exponent, the value of the power is equal to 1.

Do you see a pattern in the table at right? The negative exponent becomes positive when it is in the denominator of the fraction.

Power	Value	
10^2	100	÷ 10
10^1	10	÷ 10
10^0	1	÷ 10
10^{-1}	$\frac{1}{10^1}$ or 0.1	÷ 10
10^{-2}	$\frac{1}{10^2}$ or 0.01	÷ 10
10^{-3}	$\frac{1}{10^3}$ or 0.001	

EXAMPLE 1 Evaluating Negative Exponents

Evaluate 10^{-4}.

$10^{-4} = \frac{1}{10^4}$ *Write the fraction with a positive exponent in the denominator.*

$= \frac{1}{10{,}000}$ *Evaluate the power.*

$= 0.0001$ *Write the decimal form.*

In Chapter 1, you learned to write large numbers in scientific notation using powers of ten with positive exponents. In the same way, you can write very small numbers in scientific notation using powers of ten with negative exponents.

EXAMPLE 2 Writing Small Numbers in Scientific Notation

Write 0.000065 in scientific notation.

Remember!

Move the decimal point to get a number that is greater than or equal to 1 and less than 10.

$0.000065 = 0.000065$ *Move the decimal point 5 places to the right.*

$= 6.5 \times 0.00001$ *Write as a product of two factors.*

$= 6.5 \times 10^{-5}$ *Write in exponential form. Since the decimal point was moved 5 places, the exponent is −5.*

EXAMPLE 3 Writing Small Numbers in Standard Form

Write 3.4×10^{-6} in standard form.

$3.4 \times 10^{-6} = 0.0000003.4$ *Since the exponent is −6, move the decimal point 6 places to the left.*

$= 0.0000034$

When comparing numbers in scientific notation, you may need to compare only the powers of ten to see which value is greater.

EXAMPLE 4 Comparing Numbers Using Scientific Notation

Compare. Write <, >, or =.

A $3.7 \times 10^{-8} \square 6.1 \times 10^{-12}$

$10^{-8} > 10^{-12}$ *Compare the powers of ten.*

Since $10^{-8} > 10^{-12}$, $3.7 \times 10^{-8} > 6.1 \times 10^{-12}$.

B $4.9 \times 10^{-5} \square 7.3 \times 10^{-5}$

$10^{-5} = 10^{-5}$ *Compare the powers of ten.*

Since the powers of ten are equal, compare the decimals.

$4.9 < 7.3$ *4 is less than 7.*

Since $4.9 < 7.3$, $4.9 \times 10^{-5} < 7.3 \times 10^{-5}$.

EXTENSION Exercises

Find each value.

1. 10^{-8} **2.** 10^{-6} **3.** 10^{-5} **4.** 10^{-10} **5.** 10^{-7}

Write each number in scientific notation or standard form.

6. 0.00000021 **7.** 0.00086 **8.** 0.0000000066 **9.** 0.007

10. 0.0009 **11.** 0.0453 **12.** 0.0701 **13.** 0.00003021

14. 5.8×10^{-9} **15.** 4.5×10^{-5} **16.** 3.2×10^{-3} **17.** 1.4×10^{-11}

18. 2.77×10^{-1} **19.** 9.06×10^{-2} **20.** 7×10^{-10} **21.** 8×10^{-8}

Compare. Write <, >, or =.

22. $7.6 \times 10^{-1} \square 7.7 \times 10^{-1}$ **23.** $8.2 \times 10^{-7} \square 8.1 \times 10^{-6}$

24. $2.8 \times 10^{-6} \square 2.8 \times 10^{-7}$ **25.** $5.5 \times 10^{-2} \square 2.2 \times 10^{-5}$

26. Write About It Explain the effect that a zero exponent has on a power.

Scientific Notation

Name: _____ Date: _____

Convert each number from scientific notation to real.

(1) 1.145×10^{-6}

(2) 1.669×10^{-3}

(3) 1.911×10^{-1}

(4) 1.097×10^{-1}

(5) 8.839×10^{-6}

(6) 3.861×10^{-1}

(7) 3.642×10^{-1}

(8) 3.464×10^{-6}

(9) 8.427×10^{-6}

(10) 3.338×10^{-6}

Convert each number from real to scientific notation.

(11) 0.03689

(12) 0.00002153

(13) 0.00002583

(14) 0.0007826

(15) 0.05793

(16) 0.00001743

(17) 0.09558

(18) 0.000002434

(19) 8.275

(20) 0.003756

Scientific Notation

Name: _____ Date: _____

Convert each number from scientific notation to real.

(1) 4.815×10^{3}

(2) 1.789×10^{-6}

(3) 1.485×10^{-5}

(4) 4.216×10^{5}

(5) 7.996×10^{6}

(6) 7.652×10^{6}

(7) 9.199×10^{1}

(8) 7.724×10^{-3}

(9) 9.413×10^{4}

(10) 9.944×10^{5}

Convert each number from real to scientific notation.

(11) 0.03358

(12) 0.07443

(13) 0.009661

(14) 792,600

(15) 9,815,000

(16) 0.02537

(17) 0.06231

(18) 0.00001466

(19) 52,510

(20) 51.79