1-7 Scientific Notation

Objective To write numbers in standard notation as numbers in scientific notation, and vice versa • To perform operations in scientific notation

A mature male elephant can weigh as much as 24,750 pounds, which is 396,000 ounces. The weight of a feather is about 0.0125 ounces. You can write these numbers in scientific notation.

► Very large or very small numbers can be rewritten in scientific notation so that they are in the form of $a \times 10^n$, where $a \geq 1$ and $a < 10$, and n is an integer.

- To write a *number greater than 1* in scientific notation, move the decimal point to the left.

Move 5 places. | 5 zeros

$396{,}000 = 3.9600\,0. \times 100{,}000$ ← Move the decimal point to the *left*.

$= 3.96 \times 10^5$ ← Rename 100,000 as a power of 10.

$a \geq 1$ and $a < 10$ | power of 10

In scientific notation, $396{,}000 = 3.96 \times 10^5$.

- To write a *decimal between 0 and 1* in scientific notation, move the decimal point to the right.

Move 2 places. | 2 zeros

$0.0125 = 0.01.25 \times \frac{1}{100}$

Remember: $\frac{1}{100} = \frac{1}{10^2} = 10^{-2}$

$= 1.25 \times 10^{-2}$ ← Move the decimal point to the *right*. So multiply by a negative power of 10.

$a \geq 1$ and $a < 10$ | power of 10

In scientific notation, $0.0125 = 1.25 \times 10^{-2}$.

Key Concept

Writing a Number in Scientific Notation

To write a number in scientific notation, express it as a product of two factors.

1. Express one factor as a number greater than or equal to 1 but less than 10. Move the decimal point to the *left* or *right*.
2. Express the other factor as a power of 10. Count the number of places the decimal point was moved to the left or right, and use this number as the *exponent* of the power of 10.

► To write a number expressed in scientific notation as a number in standard form, multiply the factors.

Scientific Notation	Standard Form
$2.98 \times 10^5 = 2.98 \times 100{,}000 = 2.98000. =$	$298{,}000$ ← To multiply by 10^5, move the decimal point 5 places to the *right*.
power of 10 | 5 zeros | Move 5 places.	
$7.08 \times 10^{-3} = 7.08 \times \frac{1}{1000} = 0.007.08 =$	0.00708 ← To multiply by 10^{-3}, move the decimal point 3 places to the *left*.
power of 10 | 3 zeros | Move 3 places.	

▶ To add or subtract numbers in scientific notation, add the decimal factors, then multiply the sum by the common power of 10. Write the result in scientific notation.

Simplify: $9.7 \times 10^5 + 7.3 \times 10^5 - 2 \times 10^5$

$9.7 \times 10^5 + 7.3 \times 10^5 - 2 \times 10^5$ ← All the terms have the same power of 10.

$(9.7 + 7.3 - 2) \times 10^5$ ← Group the decimal factors; keep the common power of 10.

15×10^5 ← Simplify the decimal factors.

$(1.5 \times 10^1) \times 10^5$ ← Write 15 in scientific notation.

1.5×10^6 ← Multiply the powers of 10 by adding their exponents.

So $9.7 \times 10^5 + 7.3 \times 10^5 - 2 \times 10^5 = 1.5 \times 10^6$.

▶ To multiply or divide numbers in scientific notation, multiply or divide the decimal factors, then multiply or divide the powers of 10. Simplify and write the product in scientific notation.

- Multiply: $(6.1 \times 10^7)(2.3 \times 10^4)$

$(6.1 \times 2.3)(10^7 \times 10^4)$ ← Group like factors.

14.03×10^{11} ← Multiply the decimal factors. Then multiply the powers of 10 by adding their exponents.

$(1.403 \times 10^1) \times 10^{11}$ ← Write 14.03 in scientific notation.

1.403×10^{12} ← Multiply the powers of 10 by adding their exponents.

So $(6.1 \times 10^7)(2.3 \times 10^4) = 1.403 \times 10^{12}$.

- Divide: $\dfrac{4.731 \times 10^8}{5.7 \times 10^3}$

$\dfrac{4.731}{5.7} \times \dfrac{10^8}{10^3}$ ← Group like factors.

0.83×10^5 ← Divide the decimal factors. Then divide the powers of 10 by subtracting their exponents.

$(8.3 \times 10^{-1}) \times 10^5$ ← Write 0.83 in scientific notation.

8.3×10^4 ← Multiply the powers of 10 by adding their exponents.

So $(4.731 \times 10^8) \div (5.7 \times 10^3) = 8.3 \times 10^4$.

Try These

Write in scientific notation.

1. 751,000,000,000 **2.** 0.0000000589

Write in standard form.

3. 1.34×10^{-9} **4.** 7.123×10^8

Perform the indicated operations. Express answers in scientific notation.

5. $6.9 \times 10^{-6} + 5 \times 10^{-6}$ **6.** $9.2 \times 10^8 + 6.4 \times 10^8 - 2 \times 10^8$ **7.** $(3.65 \times 10^{12})(4.7 \times 10^5)$

8. $(6.174 \times 10^{11}) \div (6.3 \times 10^6)$ **9.** $(9 \times 10^7)(4.1 \times 10^4) \div (3 \times 10^5)$ **10.** $6 \times 10^{13} + (4 \times 10^8)(1.1 \times 10^5)$

11. Discuss and Write Explain how to add 4.77×10^9 and 7.35×10^8 even though the given powers of 10 are not the same.

Go to PRACTICE BOOK Lesson 1-7 for exercise sets.