Lesson 8

Performing Operations in Scientific Notation

8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Understand the Standards

Words to Know
scientific notation

Carly needs to find the product of the two large numbers below. To make her calculations easier, she writes the numbers in **scientific notation**.

$$2{,}300{,}000 \times 50{,}000{,}000 = (2.3 \times 10^6)(5 \times 10^7)$$

Carly then uses the associative property of multiplication to regroup the numbers. She groups the powers of ten together and she groups the factors 2.3 and 5 together.

$$(2.3 \times 5)(10^6 \times 10^7)$$

Carly then multiples the terms in parentheses.

$$(11.5)(10^{13})$$

Notice that the product 11.5×10^{13} is *not* written in proper scientific notation since the first factor, 11.5, is not a number between 1 and 10. Move the decimal point one place value to the left to get 1.15. Since you moved the decimal point one place value to the left, you need to add 1 to the exponent: $13 + 1 = 14$.

$$11.5 \times 10^{13} = 1.15 \times 10^{14}$$

Her final answer: $2{,}300{,}000 \times 50{,}000{,}000 = (2.3 \times 10^6)(5 \times 10^7) = 1.15 \times 10^{14}$.

When multiplying or dividing numbers in scientific notation, you can regroup the factors as shown below:

$$(a \times 10^x)(b \times 10^y) = ab \times 10^x 10^y = ab \times 10^{x+y} \qquad \frac{a \times 10^x}{b \times 10^y} = \frac{a}{b} \times \frac{10^x}{10^y} = \frac{a}{b} \times 10^{x-y}$$

When adding or subtracting numbers in scientific notation, you can *only* add or subtract the numbers if the powers of 10 are the same. If the powers are not the same, write the numbers in standard notation, and then add or subtract.

$(7 \times 10^5) + (8 \times 10^9) = 700{,}000 + 8{,}000{,}000{,}000 = 8{,}000{,}700{,}000$

$(7 \times 10^5) + (8 \times 10^5) = 15 \times 10^5 = 1.5 \times 10^6$ or 1,500,000

$$= (7 + 8) \times 10^5$$

$$(a \times 10^b) + (c \times 10^b) = (a + c) \times 10^b$$

Guided Instruction

Follow these steps to simplify the expression $\frac{8.64 \times 10^{-3}}{3 \times 10^{4}}$.

Step 1 Use the associative property to regroup the terms. Group the powers of ten together. Group 8.64 and 3 together.

$$\frac{8.64 \times 10^{-3}}{3 \times 10^{4}} = \frac{8.64}{3} \times \frac{10^{-3}}{10^{4}}$$

Step 2 Divide the first factors, 8.64 and 3.

$$= 2.88 \times \frac{10^{-3}}{10^{4}}$$

Step 3 Divide the powers of ten. Remember to *subtract* the exponents.

$$= 2.88 \times 10^{-3-4} = 2.88 \times 10^{-7}$$

The expression $\frac{8.64 \times 10^{-3}}{3 \times 10^{4}}$ simplifies to 2.88×10^{-7}.

When performing operations with numbers in scientific notation, make sure the final answer is written using proper scientific notation.

Simplify the expression $(2.5 \times 10^{8})(4.2 \times 10^{3})$.

Step 1 Use the associative property to regroup the terms. Group the powers of ten together. Group 2.5 and 4.2 together.

$$(2.5 \times 10^{8})(4.2 \times 10^{3})$$
$$= (2.5 \times 4.2) \times (10^{8} \times 10^{3})$$

Step 2 Multiply the first factors, 2.5 and 4.2.

$$10.5 \times (10^{8} \times 10^{3})$$

Step 3 Multiply the powers of ten. Remember to *add* the exponents.

$$= 10.5 \times 10^{8+3} = 10.5 \times 10^{11}$$

Step 4 Notice that the answer in Step 3 is not in scientific notation. Divide 10.5 by 10 so the first factor is less than 10. Then multiply 10^{11} by 10.

$$10.5 \div 10 = 1.05$$
$$10^{11} \times 10 = 10^{12}$$

The expression $(2.5 \times 10^{8})(4.2 \times 10^{3})$ simplifies to 1.05×10^{12}.

On Your Own

Use the strategy above to simplify each numerical expression.

1. $(4.5 \times 10^{6})(2 \times 10^{7})$

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2. $(3.6 \times 10^{14}) \div (9 \times 10^{4})$

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Use what you know about performing operations with scientific notation to simplify each expression.

3. $(1.3 \times 10^{8})(5 \times 10^{2})$

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4. $(1.3 \times 10^{8}) \div (5 \times 10^{2})$

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5. $(9 \times 10^{7})^{2}$

_____

6. $(0.00008)(2.3 \times 10^{10})$

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7. $(5 \times 10^3) + (5 \times 10^4) + (5 \times 10^5)$

8. $(0.00000072) \div (0.00003)$

Answer the questions. Share your ideas with a classmate.

Elevate **9.** How can you write the product of $(w \times 10^x)^y$ in scientific notation? Explain.

Elevate **10.** Thomas finds the product of 2.8×10^{13} and 5×10^{14} using a scientific calculator. His calculator shows that the answer is 1.4 E28. Explain what this answer means.

Answer the questions below.

11. Since 1993 the global average sea level has risen 3.1×10^{-3} meters per year due to melting glaciers and other factors. Which of the following units is equivalent to 3.1×10^{-3} meters per year?

A. 3.1 kilometers per year

B. 3.1 centimeters per year

C. 3.1 decimeters per year

D. 3.1 millimeters per year

12. What is the value of $(2 \times 10^2)(2 \times 10^3)(2 \times 10^4)$?

13. Simplify the expression $\frac{(5.6 \times 10^{13})(7 \times 10^{-2})}{2.45 \times 10^6}$.

Elevate **14.** Some numbers are so large that you need a computer to generate them. A googol, for example, is a famous number that equals 10^{100}. When generated by a computer, it looks like a 1 followed by one hundred zeroes.

$10^{10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000}$

A googolplex is an even larger number. It equals $10^{(10^{100})}$. When generated by a computer, how many zeroes will follow the one in a googolplex? Can you think of another way to write that number? Explain.

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