

**Solve & Discuss It!**

Scientists often write very large or very small numbers using exponents. How might a scientist write the number shown using exponents?



0.0000274983465308273400720985

**Lesson 2-9**  
Understand Scientific Notation

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**I can...**  
use scientific notation to write very large or very small quantities.

**Use Structure** How can you use your knowledge of powers of 10 to rewrite the number?

**Focus on math practices**

**Look for Relationships** What does the exponent in  $10^{15}$  tell you about the value of the number?

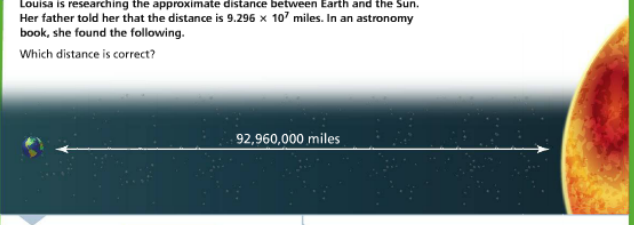
135

**Essential Question** What is scientific notation and why is it used?

**EXAMPLE 1** Write Large Numbers in Scientific Notation

Louisa is researching the approximate distance between Earth and the Sun. Her father told her that the distance is  $9.296 \times 10^7$  miles. In an astronomy book, she found the following.

Which distance is correct?



Write the number in standard form in scientific notation.

Place the decimal point after the first nonzero digit.

$9.296,000$   
7 digits  
 $\downarrow$   
 $9.296 \times 10^7$

Count the number of digits after the decimal point to determine the power of 10.

The two numbers represent the same distance.

**Try It!**

The height of Angel Falls, the tallest waterfall in the world, is 3,212 feet. How do you write this number in scientific notation?

.          $\times 10^{$    $}$

**Convince Me!** Why do very large numbers have positive exponents when written in scientific notation? Explain.

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**EXAMPLE 2** Write Small Numbers in Scientific Notation

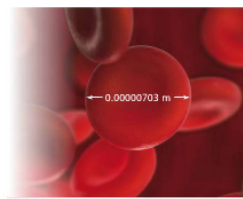
What is the width of a red blood cell written in scientific notation?

Write the number as the product of two factors.

Place the decimal after the first nonzero digit. Count the number of digits before the decimal point to determine the power of 10.

$$0.00000703 \rightarrow 7.03 \times 10^{-6}$$

The width of the red blood cell, expressed in scientific notation, is  $7.03 \times 10^{-6}$  meter.



**Try It!**

A common mechanical pencil lead measures about 0.005 meter in diameter. How can you express this measurement using scientific notation?

**EXAMPLE 3** Convert Scientific Notation to Standard Form

A. Kelly used a calculator to multiply large numbers. How can she write the number on her calculator screen in standard form?

$$3.5 \times 10^{15} = 3,500,000,000,000,000$$

The exponent is positive so move the decimal point to the right.



B. How can Charlie write the number on the calculator screen in standard form?

$$8 \times 10^{-9} = 0.000000008$$

The exponent is negative so move the decimal point to the left.



**Use Appropriate Tools** Certain calculators may display scientific notation using the symbol EE or E. The number that follows is the power of 10.

**Try It!**

Write the numbers in standard form.

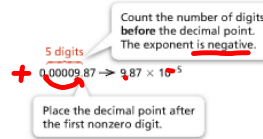
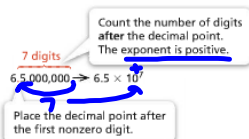
a.  $9.225 \times 10^{18}$

b.  $6.3 \times 10^{-8}$

**KEY CONCEPT**

Scientific notation is a way to write very large numbers or very small numbers. Scientists use scientific notation as a more efficient and convenient way of writing such numbers.

A number in scientific notation is the product of two factors. The first factor must be greater than or equal to 1 and less than 10. The second factor is a power of 10.



To write a number in scientific notation in standard form, multiply the decimal number by the power of 10.

**Do You Understand?**

- Essential Question** What is scientific notation and why is it used?
- Critique Reasoning** Taylor states that 2,800,000 in scientific notation is  $2.8 \times 10^{-6}$  because the number has six places to the right of the 2. Is Taylor's reasoning correct?
- Construct Arguments** Sam will write 0.000032 in scientific notation. Sam thinks that the exponent of 10 will be positive. Do you agree? Construct an argument to support your response.

**Do You Know How?**

- Express 586,400,000 in scientific notation.   
 *Handwritten: large = +exp, 5.864 x 10^8*
- The genetic information of almost every living thing is stored in a tiny strand called DNA. Human DNA is 3 nanometers or  $3 \times 10^{-9}$  meter long. Write the length in standard form.   
 *Handwritten: smaller ←, 0.000000003, 0.000000003 m*
- How would you write the number displayed on the calculator screen in standard form?   
 *Calculator screen shows 7.6E12*

Name: \_\_\_\_\_

**Practice & Problem Solving**

**Leveled Practice** In 8 and 9, write the numbers in the correct format.

8. The Sun is  $1.5 \times 10^8$  kilometers from Earth.  
 $1.5 \times 10^8$  is written as  in standard form.


9. Brenna wants an easier way to write 0.0000000000000000587.  
 $0.0000000000000000587$  is written as   $\times 10^{\text{$  in scientific notation.

10. Is  $23 \times 10^{-8}$  written in scientific notation? Justify your response.

11. Is  $8.6 \times 10^7$  written in scientific notation? Justify your response.

**\* one digit to left of decimal point**

12. Simone evaluates an expression using her calculator. The calculator display is shown at the right. Express the number in standard form.

  $\rightarrow 5.2 \times 10^{-11}$   
*small*

0.0000000000000000052  
 0.000000000000000052


13. Express the number 0.0001038 in scientific notation. *small  $\rightarrow$  neg exp*

0.0001038  
 $1.038 \times 10^{-5}$

14. Express the number 80,000 in scientific notation. *large  $\rightarrow$  pos. exp.*

80000  
 $8 \times 10^4$   
 or  $8.0 \times 10^4$

15. Peter evaluates an expression using his calculator. The calculator display is shown at the right. Express the number in standard form.




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16. a. What should you do first to write  $5.871 \times 10^{-4}$  in standard form?  
 b. Express the number in standard form.

17. Express  $2.58 \times 10^{-2}$  in standard form.

18. At a certain point, the Grand Canyon is approximately 1,600,000 centimeters across. Express this number in scientific notation.




19. The length of a bacterial cell is  $5.2 \times 10^{-6}$  meter. Express the length of the cell in standard form.

20. Higher Order Thinking Express the distance 4,300,000 meters using scientific notation in meters, and then in millimeters.

**Assessment Practice**

21. Which of the following numbers is written in scientific notation?  
 Ⓐ  $12 \times 10^6$   
 Ⓑ 12  
 Ⓒ  $6.89 \times 10^5$   
 Ⓓ 6.89
22. Jeana's calculator display shows the number to the right.

**PART A**  
 Express this number in scientific notation.  
 $5.49 \times 10^{14}$

  $5.49 \times 10^{14}$   
*large*

**PART B**  
 Express this number in standard form.

549,000,000,000,000  
 549 trillion  
 calc:  $5.49 \times 10^{14}$

