

6-1

Scientific Notation

Check Skills You'll Need

- 1. Vocabulary Review**
An expression using a base and an exponent is a ?.

Multiply.

2. 2×10
3. 4.51×100
4. $1.5 \times 1,000$
5. $1.803 \times 10,000$
6. $2.39 \times 1,000,000$

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Skills Handbook
p. 391

What You'll Learn

To write numbers in both standard form and scientific notation
New Vocabulary scientific notation

Why Learn This?

When you are dealing with very large or very small numbers in science, it is helpful to be able to write them in a shorter form.

Written in standard form, or standard notation, the volume of Earth is about 259,000,000,000 cubic miles. Using scientific notation, you can write the number as 2.59×10^{11} .



| Scientific Notation | Standard Form |
|-----------------------|-------------------|
| 2.59×10^{11} | = 259,000,000,000 |

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KEY CONCEPTS Scientific Notation

A number is in **scientific notation** if the first factor is greater than or equal to 1 and less than 10 and the second factor is a power of 10.

Examples 1×10^8 1.54×10^7 9.99×10^4

Multiplying a number by 10^n , when n is positive, moves the decimal point n places to the right.

EXAMPLE Writing in Standard Form

- 1 Science** The temperature at the sun's core is about 1.55×10^7 degrees Celsius. Write the temperature in standard form.

$$1.55 \times 10^7 = 1.5500000 \leftarrow \begin{array}{l} \text{Move the decimal point 7 places to the right.} \\ \text{Insert zeros as necessary.} \end{array}$$

$$= 15,500,000$$

The temperature at the sun's core is 15,500,000°C.

Calculator Tip

1.55E7 on a calculator means 1.55×10^7 .

Quick Check

1. Write $7.66 \times 10^6 \text{ km}^2$, the area of Australia, in standard form.

To write a number in scientific notation, determine the first factor. Then write the second factor as a power of 10.

EXAMPLE Writing in Scientific Notation

- 2 A supercomputer can perform 135,300,000,000,000 operations per second. Write this quantity in scientific notation.

$$\begin{aligned}
 135,300,000,000,000 &= 1.35,300,000,000,000. && \leftarrow \text{Move the decimal point} \\
 & && \text{14 places to the left.} \\
 &= 1.353 \times 10^{14} && \leftarrow \text{Use 14 as the exponent of 10.}
 \end{aligned}$$

The supercomputer can perform 1.353×10^{14} operations per second.

Quick Check

2. Write 3,476,000 m, the moon's diameter, in scientific notation.

Numbers in scientific notation can have negative exponents. Multiplying a number by 10^n , when n is negative, moves the decimal point n places to the left.

EXAMPLE Scientific Notation With Negative Exponents

- 3 **Biology** Fingernails grow about 1.23×10^{-2} centimeter per day. Write this rate in standard form.

$$1.23 \times 10^{-2} = .0123 \quad \leftarrow \text{Move the decimal point 2 places to the left to make 1.23 less than 1.}$$

Fingernails grow about 0.0123 centimeter per day.

Quick Check

3. Write 2.5×10^{-4} inch, the diameter of a cell, in standard form.

To write a number that is less than 1 in scientific notation, determine the first factor by moving the decimal point. Then write the second factor as a negative power of ten.

EXAMPLE Numbers Less Than 1

- 4 Write the quantity 0.0000076 in scientific notation.

$$\begin{aligned}
 0.0000076 &= 0.000007.6 && \leftarrow \text{Move the decimal point 6 places to the right to} \\
 & && \text{get a factor greater than 1 but less than 10.} \\
 &= 7.6 \times 10^{-6} && \leftarrow \text{Use } -6 \text{ as the exponent of 10.}
 \end{aligned}$$

Quick Check

4. Write 0.0000035 in scientific notation.





Check Your Understanding

- Vocabulary** A number is in scientific notation if the first factor is greater than or equal to $\underline{\quad}$ and less than 10.
- Reasoning** Explain why 1.55×10^6 does not have six zeros when it is written in standard form.
- Number Sense** Is 8×10^{-5} greater than or less than 0? Explain.
- When 123.4 and 654.321 are written in scientific notation, will the exponents of 10 be the same? Explain.

Homework Exercises

For more exercises, see **Extra Skills and Word Problems**.

Write each number in standard form.

5. 3×10^3 6. 5.08×10^4 7. 4.1×10^8 8. 7.145×10^9

9. **Whales** Write the average weight of a blue whale, 2.6×10^5 lb, in standard form.

Write each number in scientific notation.

10. 4,000 11. 17,200 12. 180,000 13. 343,502

14. **Space Travel** NASA's Apollo program lasted nine years (1963–1972) and included six moon landings. Write the cost of the Apollo project, \$25,000,000,000, in scientific notation.

Write each number in standard form.

15. 2.5×10^{-3} 16. 5.12×10^{-5} 17. 1.05×10^{-2} 18. 3×10^{-7}

19. Write the size of a grain of very fine sand, about 9.35×10^{-3} cm, in standard form.

Write each number in scientific notation.

20. 0.00581 21. 0.00105 22. 0.0000078
23. 0.00002 24. 0.000000132 25. 0.000000009

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| For Exercises | See Example |
|---------------|-------------|
| 5–9 | 1 |
| 10–14 | 2 |
| 15–19 | 3 |
| 20–25 | 4 |

GPS

26. **Guided Problem Solving** The human eye's retina has about 130 million light-sensitive cells. Write this number in scientific notation.

- What is 130 million written in standard form?
- Should you move the decimal point to the right or to the left?
- How many places should you move the decimal point?

Find each value of n .

27. $1.0035 \times 10^n = 100,350,000$ 28. $56,194 = n \times 10^4$
 29. $0.000008 = 8 \times 10^n$ 30. $n \times 10^{-9} = 0.000000004802$
31. The population of the United States is expected to be 392 million people by 2050. Write this number in scientific notation.
32. **Error Analysis** Explain how you know that 492×10^5 is not in scientific notation.
33. **Astronomy** When the sun emits a solar flare, the blast wave can travel through space at 3×10^6 km/h. Use the formula $d = rt$ to find how far the wave will travel in 30 min.
34. Which number is greater, 3.14×10^{99} or 3×10^{100} ?
35. **Heat** For a 10-minute shower, you use about 5,500 kilocalories to heat 50 gallons of water. (The prefix *kilo-* means 1,000 or 10^3 .)
 a. About how many calories do you use in a 5-minute shower?
 b. Write your answer to part (a) in scientific notation.
36. **Writing in Math** A number written in scientific notation is multiplied by 100. Explain what happens to the exponent of 10.
37. **Challenge** Write $10^{29} - 10^{28}$ in scientific notation.



Test Prep and Mixed Review

Practice

Multiple Choice

38. The moon is about 380,000 kilometers from Earth. Which expression represents this measurement in scientific notation?
 (A) 3.8×10^3 km (C) 3.8×10^5 km
 (B) 3.8×10^4 km (D) 3.8×10^6 km
39. Brett buys 3 shirts and 6 pairs of socks. His brother buys 2 shirts and 4 pairs of socks. Which expression represents the total cost? Let s be the number of shirts and k be the number of pairs of socks.
 (F) $5s + 10k$ (H) $9s + 6k$
 (G) $5s - 10k$ (J) $9s - 6k$
40. Maya grows 18 plants in her garden. Some are tomatoes, and the rest are squash. She grows twice as many tomato plants as squash plants. How many squash plants does she grow?
 (A) 3 (B) 6 (C) 9 (D) 12

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| For Exercises | See Lesson |
|---------------|------------|
| 41–43 | 1–3 |

Solve each equation.

41. $x^3 = 512$ 42. $x^3 = \frac{8}{125}$ 43. $x^3 = \frac{1}{729}$