9.5 Reading Scientific Notation

Essential Question How can you read numbers that are written in scientific notation?

1 ACTIVITY: Very Large Numbers

Work with a partner.

- Use a calculator. Experiment with multiplying large numbers until your calculator gives an answer that is *not* in standard form.

- When the calculator at the right was used to multiply 2 billion by 3 billion, it listed the result as

    6.0E+18.

- Multiply 2 billion by 3 billion by hand. Use the result to explain what 6.0E+18 means.

- Check your explanation using products of other large numbers.

- Why didn't the calculator show the answer in standard form?

- Experiment to find the maximum number of digits your calculator displays. For instance, if you multiply 1000 by 1000 and your calculator shows 1,000,000, then it can display 7 digits.

2 ACTIVITY: Very Small Numbers

Work with a partner.

- Use a calculator. Experiment with multiplying very small numbers until your calculator gives an answer that is *not* in standard form.

- When the calculator at the right was used to multiply 2 billionths by 3 billionths, it listed the result as

    6.0E−18.

- Multiply 2 billionths by 3 billionths by hand. Use the result to explain what 6.0E−18 means.

- Check your explanation using products of other very small numbers.

3 ACTIVITY: Reading Scientific Notation

Work with a partner.

Each description gives an example of a number written in scientific notation. Answer the question in the description. Write your answer in standard form.

a. Nearly 1.0×10^5 dust mites can live in 1 square yard of carpet.

How many dust mites can live in 100 square yards of carpet?

b. A micron is about 4.0×10^{-5} inch. The length of a dust mite is 250 microns.

How long is a dust mite in inches?

c. About 1.0×10^{15} bacteria live in a human body.

How many bacteria are living in the humans in your classroom?

d. A micron is about 4.0×10^{-5} inch. The length of a bacterium is about 0.5 micron.

How many bacteria could lie end-to-end on your finger?

e. Earth has only about 1.5×10^8 kilograms of gold. Earth has a mass of 6.0×10^{24} kilograms.

What percent of Earth's mass is gold?

f. A gram is about 0.035 ounce. An atom of gold weighs about 3.3×10^{-22} gram.

How many atoms are in an ounce of gold?

What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you read numbers that are written in scientific notation? Why do you think this type of notation is called "scientific notation?" Why is scientific notation important?

Practice

Use what you learned about reading scientific notation to complete Exercises 3–5 on page 380.

Key Vocabulary 🔊
scientific notation,
p. 378

Study Tip ✏️
Scientific notation is used to write very small and very large numbers.

🔑 **Key Idea**

Scientific Notation

A number is written in **scientific notation** when it is represented as the product of a factor and a power of 10. The factor must be at least 1 and less than 10.

> The factor is at least 1 and less than 10. → 8.3×10^{-7} ← The power of 10 has an integer exponent.

EXAMPLE 1 Identifying Numbers Written in Scientific Notation

Tell whether the number is written in scientific notation. Explain.

a. 5.9×10^{-6}

⋮ The factor is at least 1 and less than 10. The power of 10 has an integer exponent. So, the number is written in scientific notation.

b. 0.9×10^8

⋮ The factor is less than 1. So, the number is not written in scientific notation.

🔑 **Key Idea**

Writing Numbers in Standard Form

When writing a number from scientific notation to standard form, the absolute value of the exponent tells you how many places to move the decimal point.

- If the exponent is negative, move the decimal point to the left.
- If the exponent is positive, move the decimal point to the right.

EXAMPLE 2 Writing Numbers in Standard Form

a. Write 3.22×10^{-4} in standard form.

$3.22 \times 10^{-4} = 0.000322$ Move decimal point $|-4| = 4$ places to the left.

b. Write 7.9×10^5 in standard form.

$7.9 \times 10^5 = 790{,}000$ Move decimal point $|5| = 5$ places to the right.

🔊 *Multi-Language Glossary at BigIdeasMath✓com.*

On Your Own

1. Is 12×10^4 written in scientific notation? Explain.

Write the number in standard form.

2. 6×10^7 3. 9.9×10^{-5} 4. 1.285×10^4

EXAMPLE **3**   **Comparing Numbers in Scientific Notation**

An object with a lesser density than water will float. An object with a greater density than water will sink. Use each given density (in kilograms per cubic meter) to explain what happens when you place a brick and an apple in water.

Water: 1.0×10^3 **Brick:** 1.84×10^3 **Apple:** 6.41×10^2
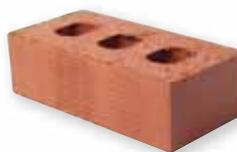
Write each density in standard form.

Water	**Brick**	**Apple**
$1.0 \times 10^3 = 1000$	$1.84 \times 10^3 = 1840$	$6.41 \times 10^2 = 641$

∵ The apple is less dense than water, so it will float. The brick is denser than water, so it will sink.

EXAMPLE **4**   **Real-Life Application**

A dog has 100 female fleas. How many milliliters of blood do the fleas consume per day?

$$1.4 \times 10^{-5} \cdot 100 = 0.000014 \cdot 100 \qquad \text{Write in standard form.}$$
$$= 0.0014 \qquad \text{Multiply.}$$

∵ The fleas consume about 0.0014 liter, or 1.4 milliliters of blood per day.
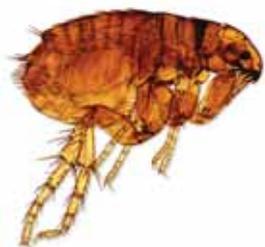
A female flea consumes about 1.4×10^{-5} liter of blood per day.

On Your Own

5. **WHAT IF?** In Example 3, the density of lead is 1.14×10^4 kilograms per cubic meter. What happens when lead is placed in water?

6. **WHAT IF?** In Example 4, a dog has 75 female fleas. How many milliliters of blood do the fleas consume per day?

Vocabulary and Concept Check

1. **WRITING** Describe the difference between scientific notation and standard form.

2. **WHICH ONE DOESN'T BELONG?** Which number does *not* belong with the other three? Explain.

$$2.8 \times 10^{15} \qquad 4.3 \times 10^{-30} \qquad 1.05 \times 10^{28} \qquad 10 \times 9.2^{-13}$$

Practice and Problem Solving

Write your answer in standard form.

3. A micrometer is 1.0×10^{-6} meter. How long is 150 micrometers in meters?

4. An acre is about 4.05×10^{7} square centimeters. How many square centimeters are in 4 acres?

5. A cubic millimeter is about 6.1×10^{-5} cubic inches. How many cubic millimeters are in 1.22 cubic inches?

Tell whether the number is written in scientific notation. Explain.

① 6. 1.8×10^{9} 7. 3.45×10^{14} 8. 0.26×10^{-25}

9. 10.5×10^{12} 10. 46×10^{-17} 11. 5×10^{-19}

12. 7.814×10^{-36} 13. 0.999×10^{42} 14. 6.022×10^{23}

Write the number in standard form.

② 15. 7×10^{7} 16. 8×10^{-3} 17. 5×10^{2}

18. 2.7×10^{-4} 19. 4.4×10^{-5} 20. 2.1×10^{3}

21. 1.66×10^{9} 22. 3.85×10^{-8} 23. 9.725×10^{6}

24. **ERROR ANALYSIS** Describe and correct the error in writing the number in standard form.

✗ $4.1 \times 10^{-6} = 4100000$

25. **PLATELETS** Platelets are cell-like particles in the blood that help form blood clots.

   a. How many platelets are in 3 milliliters of blood? Write your answer in standard form.

   b. An adult body contains about 5 liters of blood. How many platelets are in an adult body?

2.7×10^{8} platelets per milliliter

26. REASONING A googol is 1.0×10^{100}. How many zeros are in a googol?

③ 27. STARS The table shows the surface temperatures of five stars.

    a. Which star has the highest surface temperature?

    b. Which star has the lowest surface temperature?

Star	Betelgeuse	Bellatrix	Sun	Aldebaran	Rigel
Surface Temperature (°F)	6.2×10^3	3.8×10^4	1.1×10^4	7.2×10^3	2.2×10^4

28. CORAL REEF The area of the Florida Keys National Marine Sanctuary is about 9.6×10^3 square kilometers. The area of the Florida Reef Tract is about 16.2% of the area of the sanctuary. What is the area of the Florida Reef Tract in square kilometers?

29. REASONING A gigameter is 1.0×10^6 kilometers. How many square kilometers are in 5 square gigameters?

30. WATER There are about 1.4×10^9 cubic kilometers of water on Earth. About 2.5% of the water is fresh water. How much fresh water is on Earth?

31. *Critical Thinking* The table shows the speed of light through five media.

    a. In which medium does light travel the fastest?

    b. In which medium does light travel the slowest?

Medium	Speed
Air	6.7×10^8 mi/h
Glass	6.6×10^8 ft/sec
Ice	2.3×10^5 km/sec
Vacuum	3.0×10^8 m/sec
Water	2.3×10^{10} cm/sec

Fair Game Review What you learned in previous grades & lessons

Simplify. Write the expression using only positive exponents.

32. $6^3 \cdot 6^5$ **33.** $10^2 \cdot 10^5$ **34.** $8^{-1} \cdot 8^{-11}$ **35.** $10^{-6} \cdot 10^{-10}$

36. MULTIPLE CHOICE What is the length of the hypotenuse of the right triangle?

    Ⓐ $\sqrt{18}$ in.   Ⓑ $\sqrt{41}$ in.

    Ⓒ 18 in.   Ⓓ 41 in.

4 in.

5 in.