Essential Question How can you write a number in scientific notation?

1 ACTIVITY: Finding pH Levels

Work with a partner. In chemistry, pH is a measure of the activity of dissolved hydrogen ions (H^+). Liquids with low pH values are called acids. Liquids with high pH values are called bases.

Find the pH of each liquid. Is the liquid a base, neutral, or an acid?

a. Lime juice:
   $[H^+] = 0.01$

b. Egg:
   $[H^+] = 0.00000001$

c. Distilled water:
   $[H^+] = 0.0000001$

d. Ammonia water:
   $[H^+] = 0.00000000001$

e. Tomato juice:
   $[H^+] = 0.0001$

f. Hydrochloric acid:
   $[H^+] = 1$

pH	$[H^+]$	
14	1×10^{-14}	
13	1×10^{-13}	
12	1×10^{-12}	
11	1×10^{-11}	Bases
10	1×10^{-10}	
9	1×10^{-9}	
8	1×10^{-8}	
7	1×10^{-7}	Neutral
6	1×10^{-6}	
5	1×10^{-5}	
4	1×10^{-4}	
3	1×10^{-3}	Acids
2	1×10^{-2}	
1	1×10^{-1}	
0	1×10^{0}	

2 ACTIVITY: Writing Scientific Notation

Work with a partner. Match each planet with its description. Then write each of the following in scientific notation.

- Distance from the Sun (in miles)
- Distance from the Sun (in feet)
- Mass (in kilograms)

Neptune

Uranus

Saturn

Jupiter

Mars

Earth

Venus

Mercury

Sun

a. Distance: 1,800,000,000 miles

Mass: 87,000,000,000,000,000,000,000,000 kg

b. Distance: 67,000,000 miles

Mass: 4,900,000,000,000,000,000,000,000 kg

c. Distance: 890,000,000 miles

Mass: 570,000,000,000,000,000,000,000,000 kg

d. Distance: 93,000,000 miles

Mass: 6,000,000,000,000,000,000,000,000 kg

e. Distance: 140,000,000 miles

Mass: 640,000,000,000,000,000,000,000 kg

f. Distance: 2,800,000,000 miles

Mass: 100,000,000,000,000,000,000,000,000 kg

g. Distance: 480,000,000 miles

Mass: 1,900,000,000,000,000,000,000,000,000 kg

h. Distance: 36,000,000 miles

Mass: 330,000,000,000,000,000,000,000 kg

3 ACTIVITY: Making a Scale Drawing

Work with a partner. The illustration in Activity 2 is not drawn to scale. Make a scale drawing of the distances in our solar system.

- Cut a sheet of paper into three strips of equal width. Tape the strips together.
- Draw a long number line. Label the number line in hundreds of millions of miles.
- Locate each planet's position on the number line.

What Is Your Answer?

4. IN YOUR OWN WORDS How can you write a number in scientific notation?

Practice ▶ Use what you learned about writing scientific notation to complete Exercises 3–5 on page 386.

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Key Idea

Writing Numbers in Scientific Notation

Step 1: Move the decimal point to the right of the first nonzero digit.

Step 2: Count the number of places you moved the decimal point. This determines the exponent of the power of 10.

Number greater than or equal to 10

Use a positive exponent when you move the decimal point to the left.

$$8600 = 8.6 \times 10^3$$
3

Number between 0 and 1

Use a negative exponent when you move the decimal point to the right.

$$0.0024 = 2.4 \times 10^{-3}$$
3

EXAMPLE 1 Writing Large Numbers in Scientific Notation

Google purchased YouTube for $1,650,000,000. Write this number in scientific notation.

The number is greater than 1. So, move the decimal point 9 places to the left.

$$1,650,000,000 = 1.65 \times 10^9$$
9

The exponent is positive.

EXAMPLE 2 Writing Small Numbers in Scientific Notation

The 2004 Indonesian earthquake slowed the rotation of Earth, making the length of a day 0.00000268 second shorter. Write this number in scientific notation.

The number is between 0 and 1. So, move the decimal point 6 places to the right.

$$0.00000268 = 2.68 \times 10^{-6}$$
6

The exponent is negative.

On Your Own

Now You're Ready
Exercises 3–11

Write the number in scientific notation.

1. 50,000
2. 25,000,000
3. 683
4. 0.005
5. 0.00000033
6. 0.000506

EXAMPLE **3** **Standardized Test Practice**

An album has sold 8,780,000 copies. How many more copies does it need to sell to receive the award?

(A) 1.22×10^{-7}　　　　　(B) 1.22×10^{-6}

(C) 1.22×10^{6}　　　　　(D) 1.22×10^{7}

Use a model to solve the problem.

Remaining sales needed for award = Sales required for award − Current sales total

$= 10{,}000{,}000 - 8{,}780{,}000$

$= 1{,}220{,}000$

$= 1.22 \times 10^{6}$

∴ The album must sell 1.22×10^{6} more copies to receive the award. The correct answer is (C).

An album receives an award when it sells 10,000,000 copies.

🔴 **On Your Own**

7. An album has sold 955,000 copies. How many more copies does it need to sell to receive the award? Write your answer in scientific notation.

EXAMPLE **4** **Multiplying Numbers in Scientific Notation**

Find $(3 \times 10^{-5}) \times (5 \times 10^{-2})$. Write your answer in scientific notation.

$(3 \times 10^{-5}) \times (5 \times 10^{-2})$

$= 3 \times 5 \times 10^{-5} \times 10^{-2}$　　　Commutative Property of Multiplication

$= (3 \times 5) \times (10^{-5} \times 10^{-2})$　　Associative Property of Multiplication

$= 15 \times 10^{-7}$　　　　　Simplify.

$= 1.5 \times 10^{1} \times 10^{-7}$　　　Write factor in scientific notation.

$= 1.5 \times 10^{-6}$　　　　Simplify.

Study Tip

You can check your answer using standard form.
(3×10^{-5})
$\quad \times (5 \times 10^{-2})$
$= 0.00003 \times 0.05$
$= 0.0000015$
$= 1.5 \times 10^{-6}$

🔴 **On Your Own**

Now You're Ready
Exercises 14–19

Multiply. Write your answer in scientific notation.

8. $(2.5 \times 10^{8}) \times (2 \times 10^{3})$　　　9. $(2 \times 10^{-4}) \times (1 \times 10^{-4})$

10. $(5 \times 10^{-4}) \times (5.4 \times 10^{-9})$　　11. $(7 \times 10^{2}) \times (3 \times 10^{5})$

Check It Out
Help with Homework
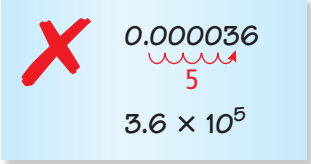BigIdeasMath.com

Vocabulary and Concept Check

1. **REASONING** How do you know whether a number written in standard form will have a positive or negative exponent when written in scientific notation?

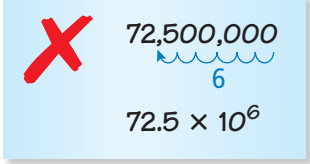2. **WRITING** Describe how to write a number in scientific notation.

Practice and Problem Solving

Write the number in scientific notation.

3. 0.0021
4. 5,430,000
5. 321,000,000

6. 0.00000625
7. 0.00004
8. 10,700,000

9. 45,600,000,000
10. 0.000000000009256
11. 840,000

ERROR ANALYSIS Describe and correct the error in writing the number in scientific notation.

12.

✗ 0.000036
       5
    3.6×10^5

13.

✗ 72,500,000
         6
    72.5×10^6

Multiply. Write your answer in scientific notation.

14. $(4 \times 10^4) \times (2 \times 10^6)$
15. $(3 \times 10^{-8}) \times (3 \times 10^{-2})$

16. $(5 \times 10^{-7}) \times (3 \times 10^6)$
17. $(8 \times 10^3) \times (2 \times 10^4)$

18. $(6 \times 10^8) \times (1.4 \times 10^{-5})$
19. $(7.2 \times 10^{-1}) \times (4 \times 10^{-7})$

20. HAIR What is the diameter of a human hair in scientific notation?

Diameter: 0.000099 meter

21. EARTH What is the circumference of Earth in scientific notation?
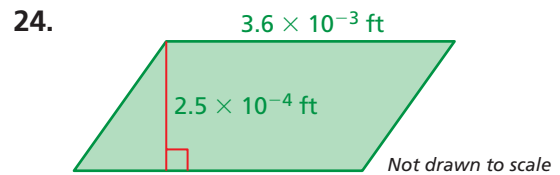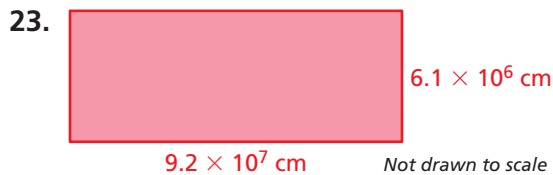
Circumference at the equator: about 40,100,000 meters

22. WATERFALLS During high flow, more than 44,380,000 gallons of water go over Niagara Falls every minute. Write this number in scientific notation.

Find the area of the figure. Write your answer in scientific notation.

23.

6.1×10^6 cm

9.2×10^7 cm   *Not drawn to scale*

24.

3.6×10^{-3} ft

2.5×10^{-4} ft

Not drawn to scale

25. SPACE SHUTTLE The power of a space shuttle during launch is the force of the solid rocket boosters multiplied by the velocity. The velocity is 3.75×10^2 meters per second. What is the power (in newton-meters per second) of the shuttle shown during launch?

Force $= 2.6 \times 10^7$ N
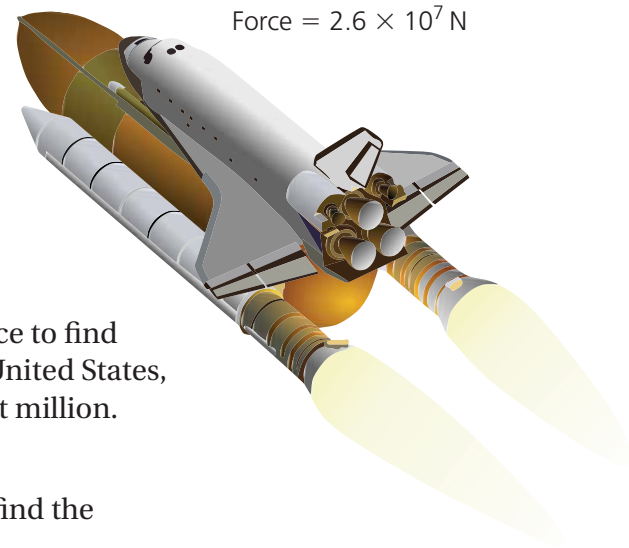
26. NUMBER SENSE Write 670 million in three ways.

27. PROJECT Use the Internet or some other reference to find the populations of India, China, Argentina, the United States, and Egypt. Round each population to the nearest million.

  a. Write each population in scientific notation.

  b. Use the Internet or some other reference to find the population density for each country.

  c. Use the results of parts (a) and (b) to find the area of each country.

$H \leftarrow 0.000074$ cm

$H \leftarrow 0.000032$ cm

4.26 cm
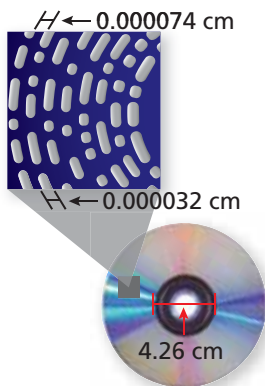
28. DVDS On a DVD, information is stored on bumps that spiral around the disk. There are 73,000 ridges (with bumps) and 73,000 valleys (without bumps) across the diameter of the DVD. What is the diameter of the DVD in centimeters?

29. **Number Sense**   Simplify. Write your answer in scientific notation.

  a. $\dfrac{(53{,}000{,}000)(0.002)}{(0.0004)}$

  b. $\dfrac{(0.33)(60{,}000)}{(90{,}000{,}000)}$

Fair Game Review   What you learned in previous grades & lessons

Write and solve an equation to answer the question.

30. 15% of 60 is what number?

31. 85% of what number is 170?

32. MULTIPLE CHOICE What is the domain of the function represented by the table? Ž

x	−2	−1	0	1	2
y	−6	−2	2	6	10

  A −2, −1, 0, 1, 2

  B −6, −2, 2, 6, 10

  C all integers

  D all whole numbers