

6-3

Multiplying with Scientific Notation

Check Skills You'll Need

1. Vocabulary Review

The second factor in *scientific notation* is a power of ?.

Write each number in scientific notation.

2. 20,000
3. 0.000005
4. 9,300,000

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Lesson 6-1

What You'll Learn

To multiply numbers written in scientific notation and choose appropriate units of measure

Why Learn This?

Astronomers use scientific notation when they work with very large numbers. To calculate using scientific notation, you must know how to multiply with exponents.



The rule for multiplying powers with the same base applies to multiplying numbers in scientific notation.

CONTENT STANDARD

8.EE.4

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For help with scientific notation, go to Lesson 6-1, Example 2.

EXAMPLE Multiplying With Scientific Notation

- 1 Multiply $(5 \times 10^6)(9 \times 10^3)$. Write the product in scientific notation.

$$\begin{aligned}
 (5 \times 10^6)(9 \times 10^3) &= (5 \times 9) \times (10^6 \times 10^3) && \leftarrow \text{Use the associative and commutative properties.} \\
 &= 45 \times (10^6 \times 10^3) && \leftarrow \text{Multiply 5 and 9.} \\
 &= 45 \times 10^9 && \leftarrow \text{Add the exponents of the powers of 10.} \\
 &= 4.5 \times 10^1 \times 10^9 && \leftarrow \text{Write 45 in scientific notation.} \\
 &= 4.5 \times 10^{10} && \leftarrow \text{Add the exponents.}
 \end{aligned}$$

Quick Check

1. Multiply. Write each product in scientific notation.

a. $(2 \times 10^6)(4 \times 10^3)$ b. $(3 \times 10^5)(2 \times 10^8)$ c. $12(8 \times 10^{20})$

Multiplying large or small numbers in scientific notation is easier than multiplying the same numbers in standard form.



EXAMPLE Application: Science

- 2 **Multiple Choice** A light-year, the distance light travels in one Earth year, is about 5.9×10^{12} miles. A mile is 5.28×10^3 feet. How many feet are in a light-year?

- (A) 31.2×10^{15} (C) 3.12×10^{15}
 (B) 31.2×10^{16} (D) 3.12×10^{16}

$$(5.9 \times 10^{12})(5.28 \times 10^3) \quad \leftarrow \text{Multiply by the conversion factor.}$$

$$(5.9 \times 5.28) \times (10^{12} \times 10^3) \quad \leftarrow \text{Associative and Commutative properties}$$

$$31.2 \times (10^{12} \times 10^3) \quad \leftarrow \text{Multiply 5.9 and 5.28. Round to the nearest tenth.}$$

$$31.2 \times 10^{15} \quad \leftarrow \text{Add the exponents of the powers of 10.}$$

$$(3.12 \times 10^1) \times 10^{15} \quad \leftarrow \text{Write 31.2 in scientific notation.}$$

$$3.12 \times 10^{16} \quad \leftarrow \text{Add the exponents.}$$

There are 3.12×10^{16} feet in a light-year. The correct answer is choice D.

Quick Check

2. **Astronomy** The speed of light is about 3.0×10^5 kilometers/second. Use the formula $d = r \cdot t$ to find the distance light travels in an hour, which is 3.6×10^3 seconds.

Often the size of the unit is close to the measurement of the object. You can also choose units that are much greater or smaller by multiplying with scientific notation.

EXAMPLE Choosing Units with Scientific Notation

- 3 Choose the most reasonable unit to describe the quantity. Then use scientific notation to describe the quantity using the other unit.

- a. The mass of a nickel is 5 _____. (g, mg) 5 g

$$5 \text{ g} \times \left(\frac{10^3 \text{ mg}}{1 \text{ g}} \right) = 5 \times 10^3 \text{ mg} \quad \leftarrow \text{Multiply by a conversion factor.}$$

- b. The length of a football field is about 91 _____. (km, m) 91 m

$$91 \text{ m} \times \left(\frac{10^{-3} \text{ km}}{1 \text{ m}} \right) = 91 \times 10^{-3} \text{ km} \quad \leftarrow \text{Multiply by a conversion factor.}$$

$$= 9.1 \times 10^{-2} \text{ km} \quad \leftarrow \text{Simplify.}$$

Quick Check

3. Choose the most reasonable unit to describe the quantity. Then use scientific notation to describe the quantity using the other unit.

A pencil is 7 _____ long. (cm, m)

Check Your Understanding

For Exercises 1–4, fill in the blank.

- $(3 \times 10^4)(6 \times 10^{12}) = 1.8 \times 10^{\blacksquare}$
- $7(1.8 \times 10^7) = \blacksquare \times 10^8$
- $(1.9 \times 10^5)(6.4 \times 10^3) = 1.216 \times \blacksquare^9$
- $5(3.2 \times 10^7) = 1.6 \times 10^{\blacksquare}$
- The speed of light is about 3.00×10^5 km/s. A kilometer is about 0.621 mi. Written in scientific notation, what is the speed of light in miles per second?
- Reasoning** Choose the most reasonable unit to complete each of the following sentences. Then use scientific notation to describe each quantity using another unit.
 - The distance between two cities is 36 _____. (m, km)
 - The mass of a teaspoon of salt is 6 _____. (g, kg)

Homework Exercises

For more exercises, see Extra Skills and Word Problems.

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For Exercises	See Examples
7–12	1, 2
13–14	3
15	2

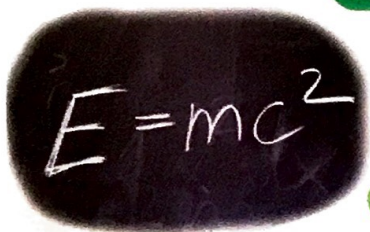
Multiply. Write each product in scientific notation.

- $(2 \times 10^3)(4 \times 10^6)$
- $(7 \times 10^2)(9 \times 10^5)$
- $90(8 \times 10^9)$
- $(3 \times 10^5)(5 \times 10^7)$
- $(9 \times 10^5)(5 \times 10^9)$
- $(5.1 \times 10^4)(2 \times 10^7)$

Choose the most reasonable unit to describe the quantity. Then use scientific notation to describe the quantity using the other unit.

- The thickness of a quarter is 1.75 _____. (cm, mm)
- The mass of a banana is 2×10^2 _____. (g, kg)
- Earth Science** There are about 4.8×10^{19} ft³ of water on Earth. One cubic foot of water contains about 9.47×10^{26} water molecules. About how many water molecules are there on Earth?
- Guided Problem Solving** Einstein's famous equation states that $E = mc^2$. E represents energy, m represents mass, and c represents the speed of light. Find the value of E (in joules) when m is equal to 1 kilogram and c is equal to 3.0×10^8 meters per second.
 - How can you write Einstein's law without using exponents?
 - Evaluate c^2 for $c = 3.0 \times 10^8$.

GPS



17. **Open-Ended** The area of a small garden is 8 m^2 . Write this area in two other ways using different units and scientific notation.
18. **Writing in Math** Explain why multiplying large or small numbers in scientific notation is easier than multiplying the same numbers in standard form.
19. Double the number 3.4×10^{12} . Write the answer in scientific notation.
20. **Geography** The Sahara is a desert of about 3.5 million square miles. There are about 2.79×10^7 square feet in a square mile. About how many square feet does the Sahara cover? Write your answer in scientific notation.
21. **Chemistry** The mass of an electron is about 9.1×10^{-31} kg. A kilogram is equal to 1×10^6 mg. What is the mass of an electron in milligrams?
22. The radius of Venus is about 6.05×10^3 km. Use the formula $S.A. = 4\pi r^2$ to approximate the surface area of Venus.
23. **Challenge** What is $(9.7 \times 10^{-5})(7.8 \times 10^5)(3.3 \times 10^{10})$?

Test Prep and Mixed Review

Practice

Multiple Choice

24. The volume of Earth is $1.08 \times 10^{12} \text{ km}^3$. The volume of Jupiter is 1,320 times that of Earth. Which is NOT a way to express the volume of Jupiter in cubic kilometers?
- (A) 142.6×10^{13} (C) 14.26×10^{13}
 (B) 14.3×10^{14} (D) 1.43×10^{15}
25. Which statement below is true?
- (F) $1.5 \times 10^2 = 1.5 \times 10^{-2}$ (H) $1.5 \times 10^2 < 1.5 \times 10^{-2}$
 (G) $1.5 \times 10^2 = 15 \times 10$ (J) $1.5 \times 10^2 > 5.1 \times 10^3$

Simplify each expression.

26. $5y - 3(2y + 3)$
 27. $18p - 3(2 - 5p)$

GO for Help

For Exercises	See Lesson
26-27	2-2