

**Goal** • Develop your understanding of using scientific notation.

## What to Do

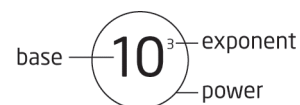
- Read about scientific notation and answer the questions that follow.

## Powers

You can write repeated multiplication in a simpler way as a power.

Powers are named after their bases, so  $10^3$  is called a power of 10.

$$10^3 = 10 \times 10 \times 10.$$



## Writing Scientific Notation

Scientific notation is a way of writing very large or very small numbers so they are easier to work with.

A number written in scientific notation is the product of a number between 1 and 9, and a power of 10.

Large numbers have a power of 10 with a positive exponent. Small numbers have a power of 10 with a negative exponent.

### Example 1

Mercury is about 58 000 000 km from the sun. Write 58 000 000 in scientific notation.

#### Solution

The number will have two parts: a number between 1 and 9, and a power of 10. The first number will be 5.8. What do you need to multiply 5.8 by to get 58 000 000?

$$58\,000\,000 = 5.8 \times 10\,000\,000 \quad \text{Write } 10\,000\,000 \text{ as a power of } 10.$$

$$= 5.8 \times 10^7$$

Check: Move the decimal in 5.8 seven places to the right and you get 58 000 000.

### Example 2

The diameter of a helium atom is about 0.000 000 000 256 m. Write 0.000 000 000 256 in scientific notation.

#### Solution

The number will have two parts: a number between 1 and 10, including 1, and a power of 10. The first number will be 2.56. What do you need to multiply 2.56 by to get 0.000 000 000 256?

$$0.000\,000\,000\,256 = 2.56 \times 0.000\,000\,000\,1 \quad \text{Write } 0.000\,000\,000\,1 \text{ as a power of } 10.$$

$$= 2.56 \times 10^{-10}$$

Check: Move the decimal in 2.56 ten places to the left and you get 0.000 000 000 256.



Express each of the following in scientific notation.

1. The approximate diameter of an electron is 0.000 000 000 000 005 6 cm.
2. Neptune is about 4 500 000 000 km from the sun.
3. The mass of a dust particle is 0.000 000 001 023 kg.

### Calculating with Scientific Notation

You can multiply and divide with numbers in scientific notation without needing to write them in standard form. Use the exponent laws to calculate the new power of 10.

Product of Powers:  $a^m \times a^n = a^{m+n}$

Quotient of Powers:  $a^m \div a^n = a^{m-n}$

#### Example 1

Convert  $9.7 \times 10^7$  AU to light years. (1 AU =  $1.58 \times 10^{-5}$  light years)

#### Solution

If you are multiplying powers with the same base, you can add the exponents.

$$\begin{aligned} 9.7 \times 10^5 \times 1.58 \times 10^{-5} &= 9.7 \times 1.58 \times 10^7 \times 10^{-5} \\ &= 15.326 \times 10^{7+(-5)} \\ &= 15.326 \times 10^2 \end{aligned}$$

Check: The first number is not between 1 and 10. Change the number to proper scientific notation.

$$15.326 \times 10^2 = 1.5326 \times 10^3 \text{ light years}$$

#### Example 2

Convert  $2.1 \times 10^8$  light years to astronomical units.  $\left(1 \text{ ly} = \frac{1}{1.58 \times 10^{-5}} \text{ AU}\right)$

#### Solution

If you are dividing powers with the same base, subtract the exponents.

$$\begin{aligned} \frac{2.1 \times 10^8}{1.58 \times 10^{-5}} &= 1.329 \times 10^{8-(-5)} \\ &= 1.329 \times 10^{13} \text{ AU} \end{aligned}$$

Check: The first number is between 1 and 10 and the second number is a power of 10, so the number is written in proper scientific notation.

Solve the following. Express your answers in proper scientific notation.

1.  $(5.75 \times 10^9) \times (1.4 \times 10^2)$
2.  $(2.6 \times 10^4) \times (3.5 \times 10^3)$
3.  $\frac{9.3 \times 10^7}{4.8 \times 10^8}$
4.  $\frac{7.3 \times 10^2}{1.3 \times 10^{-6}}$

