Lesson 2: Base 10 and Scientific Notation

Classwork

Opening Exercise

In the last lesson, you worked with the thickness of a sheet of gold foil (a very small number) and some very large numbers that gave the size of a piece of paper that actually could be folded in half more than 13 times.

a. Convert 0.28 millionths of a meter to centimeters and express your answer as a decimal number.

b. The length of a piece of square notebook paper that could be folded in half 13 times was 3294.2 in. Use this number to calculate the area of a square piece of paper that could be folded in half 14 times. Round your answer to the nearest million.

c. Sort the following numbers into products and single numeric expressions. Then match the equivalent expressions without using a calculator.

3.5×10^5	-6	-6×10^0	0.6	3.5×10^{-6}
$3{,}500{,}000$	$350{,}000$	6×10^{-1}	0.0000035	3.5×10^6

Example 1

Write each number as a product of a decimal number between 1 and 10 and a power of 10.

a. 234,000

b. 0.0035

c. 532,100,000

d. 0.0000000012

e. 3.331

Exercises 1–6

For Exercises 1–6, write each decimal in scientific notation.

1. 532,000,000

2. 0.0000000000000000123 (16 zeros after the decimal place)

3. 8,900,000,000,000,000 (14 zeros after the 9)

4. 0.00003382

5. $34{,}000{,}000{,}000{,}000{,}000{,}000{,}000$ (24 zeros after the 4)

6. $0.00000000000000000000004$ (21 zeros after the decimal place)

Exercises 7–8

7. Approximate the average distances between the Sun and Earth, Jupiter, and Pluto. Express your answers in scientific notation ($d \times 10^n$), where d is rounded to the nearest tenth.
   a. Sun to Earth:
   b. Sun to Jupiter:
   c. Sun to Pluto:
   d. Earth to Jupiter:
   e. Jupiter to Pluto:

8. Order the numbers in Exercise 7 from smallest to largest. Explain how writing the numbers in scientific notation helps you to quickly compare and order them.

Example 2: Arithmetic Operations with Numbers Written Using Scientific Notation

a. $(2.4 \times 10^{20}) + (4.5 \times 10^{21})$

b. $(7 \times 10^{-9})(5 \times 10^{5})$

c. $\frac{1.2 \times 10^{15}}{3 \times 10^{7}}$

Exercises 9–11

9. Perform the following calculations without rewriting the numbers in decimal form.

a. $(1.42 \times 10^{15}) - (2 \times 10^{13})$

b. $(1.42 \times 10^{15})(2.4 \times 10^{13})$

c. $\frac{1.42 \times 10^{-5}}{2 \times 10^{13}}$

10. Estimate how many times farther Jupiter is from the Sun than Earth is from the Sun. Estimate how many times farther Pluto is from the Sun than Earth is from the Sun.

11. Estimate the distance between Earth and Jupiter and between Jupiter and Pluto.

Problem Set

1. Write the following numbers used in these statements in scientific notation. (Note: Some of these numbers have been rounded.)
   a. The density of helium is 0.0001785 grams per cubic centimeter.
   b. The boiling point of gold is $5200°\text{F}$.
   c. The speed of light is $186{,}000$ miles per second.
   d. One second is 0.000278 hours.
   e. The acceleration due to gravity on the Sun is $900\ \text{ft/s}^2$.
   f. One cubic inch is 0.0000214 cubic yards.
   g. Earth's population in 2012 was $7{,}046{,}000{,}000$ people.
   h. Earth's distance from the sun is $93{,}000{,}000$ miles.
   i. Earth's radius is 4000 miles.
   j. The diameter of a water molecule is 0.000000028 cm.

2. Write the following numbers in decimal form. (Note: Some of these numbers have been rounded.)
   a. A light year is 9.46×10^{15} m.
   b. Avogadro's number is $6.02 \times 10^{23}\ \text{mol}^{-1}$.
   c. The universal gravitational constant is 6.674×10^{-11} N(m/kg)^2.
   d. Earth's age is 4.54×10^{9} years.
   e. Earth's mass is 5.97×10^{24} kg.
   f. A foot is 1.9×10^{-4} miles.
   g. The population of China in 2014 was 1.354×10^{9} people.
   h. The density of oxygen is 1.429×10^{-4} grams per liter.
   i. The width of a pixel on a smartphone is 7.8×10^{-2} mm.
   j. The wavelength of light used in optic fibers is 1.55×10^{-6} m.

3. State the necessary value of n that will make each statement true.
   a. $0.000027 = 2.7 \times 10^{n}$
   b. $-3.125 = -3.125 \times 10^{n}$
   c. $7{,}540{,}000{,}000 = 7.54 \times 10^{n}$
   d. $0.033 = 3.3 \times 10^{n}$
   e. $15 = 1.5 \times 10^{n}$
   f. $26{,}000 \times 200 = 5.2 \times 10^{n}$
   g. $3000 \times 0.0003 = 9 \times 10^{n}$
   h. $0.0004 \times 0.002 = 8 \times 10^{n}$
   i. $\frac{16000}{80} = 2 \times 10^{n}$
   j. $\frac{500}{0.002} = 2.5 \times 10^{n}$

Perform the following calculations without rewriting the numbers in decimal form.

k. $(2.5 \times 10^4) + (3.7 \times 10^3)$

l. $(6.9 \times 10^{-3}) - (8.1 \times 10^{-3})$

m. $(6 \times 10^{11})(2.5 \times 10^{-5})$

n. $\frac{4.5 \times 10^8}{2 \times 10^{10}}$

4. The wavelength of visible light ranges from 650 nanometers to 850 nanometers, where $1 \text{ nm} = 1 \times 10^{-7}$ cm. Express the wavelength range of visible light in centimeters.

5. In 1694, the Dutch scientist Antonie van Leeuwenhoek was one of the first scientists to see a red blood cell in a microscope. He approximated that a red blood cell was "$25{,}000$ times as small as a grain of sand." Assume a grain of sand is $\frac{1}{2}$ millimeter wide and a red blood cell is approximately 7 micrometers wide. One micrometer is 1×10^{-6} meters. Support or refute Leeuwenhoek's claim. Use scientific notation in your calculations.

6. When the Mars Curiosity Rover entered the atmosphere of Mars on its descent in 2012, it was traveling roughly $13{,}200$ mph. On the surface of Mars, its speed averaged 0.00073 mph. How many times faster was the speed when it entered the atmosphere than its typical speed on the planet's surface? Use scientific notation in your calculations.

7. Earth's surface is approximately 70% water. There is no water on the surface of Mars, and its diameter is roughly half of Earth's diameter. Assume both planets are spherical. The surface area of a sphere is given by the formula $SA = 4\pi r^2$ where r is the radius of the sphere. Which has more land mass, Earth or Mars? Use scientific notation in your calculations.

8. There are approximately 25 trillion (2.5×10^{13}) red blood cells in the human body at any one time. A red blood cell is approximately 7×10^{-6} m wide. Imagine if you could line up all your red blood cells end to end. How long would the line of cells be? Use scientific notation in your calculations.

9. Assume each person needs approximately 100 sq. ft. of living space. Now imagine that we are going to build a giant apartment building that will be 1 mile wide and 1 mile long to house all the people in the United States, estimated to be 313.9 million people in 2012. If each floor of the apartment building is 10 ft. high, how tall will the apartment building be?