Using Scientific Notation

Calculate the density of a solid material if the mass is measured as 1.50×10^2 g and its volume is measured as 5.0 cm^3.

Math Skill: Scientific Notation

You may want to read more about this **Math Skill** in the **Skills and Reference Handbook** at the end of your textbook.

1. Read and Understand

What information are you given?

Mass = 1.50×10^2 g

Volume = 5.0 cm^3

2. Plan and Solve

What unknown are you trying to calculate?

Density = ?

What formula contains the given quantities and the unknown?

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Replace each variable with its known variable and known value.

$$\text{Density} = \frac{1.50 \times 10^2\text{g}}{5.0\ \text{cm}^3}$$

$$= \frac{1.50}{5.0}\ (10^2)\left(\text{g/cm}^3\right)$$

$$= 0.30 \times 10^2\ \text{g/cm}^3$$

$$= 3.0 \times 10^1\ \text{g/cm}^3$$

3. Look back and check

Is your answer reasonable?

Yes, the number calculated is the quotient of mass and volume, and the units (g/cm^3) indicate density.

Math Practice

On a separate sheet of paper, solve the following problems. Show your work.

1. The mass of a liquid is 8.03×10^4 kg. The liquid fills up a 100,000 L tank. What is the density of this liquid?

2. You measure the mass of a piece of iron to be 17.37 g on an electronic balance. You then measure the volume to 2.21 cm^3. What is the density of the iron?

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Section 1.3 Measurement

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Math Skills: *Using Scientific Notation*

Content and Vocabulary Support

Writing Numbers in Scientific Notation

Scientific notation is a way of writing numbers that are very large or very small. It makes the numbers easier to work with by eliminating most of the zeroes. In scientific notation, a number is expressed as the product of a number from 1 to 10 and 10 raised to a power. For example, 2,000,000 (2 million) is written as 2.0×10^6. To change 2,000,000 to 2.0, the decimal point was moved six places to the left. Because the decimal point was moved six places, the power of 10 is 6.

To change a very small number (less than one) to scientific notation, you follow the same steps, except the decimal point is moved to the right. This makes the exponent a negative number. For example, 0.000002 (2 millionths) is written as 2.0×10^{-6}.

To change a number from scientific notation to standard notation, you follow the same steps in reverse order. Based on the value and sign of the exponent, write the correct number of zeroes before or after the number. Then, move the decimal point the same number of places to the left or right.

Arithmetic with Numbers in Scientific Notation

You can add and subtract numbers in scientific notation if they are raised to the same power of 10. For example:

$$(1.0 \times 10^4) + (2.2 \times 10^4) = 3.2 \times 10^4$$

You can multiply or divide any numbers in scientific notation. To multiply, first multiply the two numbers that appear before the multiplication signs. Then, add the two exponents. For example:

$$(3.1 \times 10^8) \times (2.0 \times 10^3) = (3.1 \times 2.0) \times 10^{(8+3)} = 6.2 \times 10^{11}$$

To divide, first divide the two numbers that appear before the multiplication signs. Then, subtract the two exponents. For example:

$$\frac{(4.2 \times 10^{12})}{(2.0 \times 10^3)} = \frac{4.2}{2.0} \times 10^{(12-3)} = 2.1 \times 10^9$$

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Section 1.3 Measurement

Solved Examples

Example 1: A hydrogen atom has a diameter of 0.00000001 cm. What is the diameter in scientific notation?

Given: Diameter in standard notation = 0.00000001 cm

Unknown: Diameter in scientific notation

Solution: The diameter is 1.0×10^{-8}. The decimal point is moved eight places to the right to change the number to 1.0. The exponent of 10 is therefore negative eight.

Example 2: What is the area of a rectangular playing field that is 5.0×10^3 m wide and 8.0×10^4 m long?

Given: Width (w) = 5.0×10^3 m
Length (l) = 8.0×10^4 m

Unknown: Area (A)

Equation: $A = l \times w$

Solution: $A = (8.0 \times 10^4 \text{ m}) \times (5.0 \times 10^3 \text{ m}) = 40.0 \times 10^7 \text{ m}^2$

Example 3: One side of a microchip has an area of 5×10^{-6} m^2 and a length of 5.0×10^{-3} m. What is its width?

Given: Area (A) = 5.0×10^{-6} m^2
Length (l) = 5.0×10^{-3} m

Unknown: Width (w)

Equation: $w = \frac{A}{l}$

Solution: $w = \frac{5.0 \times 10^{-6}\text{m}^2}{5.0 \times 10^{-3}\text{m}} = 1.0 \times 10^{-3} \text{ m}$

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Practice Exercises

Exercise 1: Scientists use the micron as a unit of length for very small objects. A micron is one-millionth of a meter, or 0.000001 m. Write the number of meters in a micron in scientific notation.

Exercise 2: A mountain's elevation above sea level is 9.8×10^3 m. Write the elevation in standard notation.

Exercise 3: A rectangular lake has a width of 6.0×10^3 m and a length of 1.2×10^4 m. What is the area of the lake in scientific notation?

Exercise 4: A rectangular piece of land with an area of 260,000 m^2 is 2,000 m long. Write the area and length in scientific notation, and then find the width.

Exercise 5: One surface of a cut gemstone is rectangular in shape. It is 0.0002 m wide and has an area of 0.000006 m^2. How long is the surface? Do your work in scientific notation.