1.3: Scientific Notation

In Section 1.1, we stated that a single copper penny contains approximately 28,000,000,000,000,000,000,000 atoms. This is a huge number. If we were to measure the diameter of an atom of hydrogen, it would be about 0.00000000000026 inches across. This is an incredibly small number. Chemists routinely use very large and very small numbers in calculations. In order to allow us to use this range of numbers efficiently, chemists will generally express numbers using exponential, or scientific notation. In scientific notation, a number n is shown as the product of that number and 10, raised to some exponent x; that is, ($n \times 10^x$). The number 10^2 is equal to 100. If we multiply 2×10^2, that is equivalent to multiplying 2×100, or 200. Thus 200 can be written in scientific notation as 2×10^2. When we convert a number to scientific notation, we begin by writing a the first (non-zero) digit in the number. If the number contains more than one digit, we write a decimal point, followed by all of the remaining digits. Next we inspect the number to see what power of 10 this decimal must be multiplied by to give the original number. Operationally, what you are doing is moving decimal places. Take the number of atoms in a penny, 28,000,000,000,000,000,000,000. We would begin by writing 2.8. To get the power of 10 that we need, we begin with the last digit in the number and count the number of places that we must move to the left to reach our new decimal point. In this example, we must move 22 places to the left. The number is therefore the product of 2.8 and 10^{22}, and the number is written in scientific notation as 2.8×10^{22}.

Let's look at a very small number; for example, 0.00000000000026 inches, the diameter of a hydrogen atom. We want to place our decimal point between the two and the six. To do this, we have to move the decimal point in our number to the right thirteen places. When you are converting a number to scientific notation and you move the decimal point to the right, the power of 10 must have a negative exponent. Thus our number would be written 2.6×10^{-13} inches. A series of numbers in decimal format and in scientific notation are shown in Table $1.3.1$ below.

Table $1.3.1$: Examples of Numbers in Decimal Format and in Scientific Notation

Decimal Format	Scientific Notation
274	2.74×10^2
0.0035	3.5×10^{-3}
60221415	6.0221415×10^7
0.125	1.25×10^{-1}
402.5	4.025×10^2
0.0002001	2.001×10^{-4}
10,000	1×10^4

Exercise $1.3.1$

Convert the following numbers into scientific notation:

a. 93,000,000
b. 708,010
c. 0.000248
d. 800.0

Exercise $1.3.2$

Convert the following numbers from scientific notation into decimal format:

a. 6.02×10^4
b. 6.00×10^{-4}
c. 4.68×10^{-2}
d. 9.3×10^7