Mathematical Review

Scientific Notation

Positive exponents Many quantities that scientists deal with often have very large or very small values. For example, the speed of light is about 300 000 000 m/s, and the ink required to make the dot over an *i* in this textbook has a mass of about 0.000 000 001 kg. Obviously, it is cumbersome to work with numbers such as these. We avoid this problem by using a method based on powers of the number 10.

$$10^0 = 1$$
$$10^1 = 10$$
$$10^2 = 10 \times 10 = 100$$
$$10^3 = 10 \times 10 \times 10 = 1000$$
$$10^4 = 10 \times 10 \times 10 \times 10 = 10\,000$$
$$10^5 = 10 \times 10 \times 10 \times 10 \times 10 = 100\,000$$

The number of zeros determines the power to which 10 is raised, or the *exponent* of 10. For example, the speed of light, 300 000 000 m/s, can be expressed as 3×10^8 m/s. In this case, the exponent of 10 is 8.

Negative exponents For numbers less than one, we note the following:

$$10^{-1} = \frac{1}{10} = 0.1$$
$$10^{-2} = \frac{1}{10 \times 10} = 0.01$$
$$10^{-3} = \frac{1}{10 \times 10 \times 10} = 0.001$$
$$10^{-4} = \frac{1}{10 \times 10 \times 10 \times 10} = 0.0001$$
$$10^{-5} = \frac{1}{10 \times 10 \times 10 \times 10 \times 10} = 0.000\,01$$

The value of the negative exponent equals the number of places the decimal point must be moved to be to the right of the first nonzero digit (in these cases, the digit 1). Numbers that are expressed as a number between 1 and 10 multiplied by a power of 10 are said to be in *scientific notation.* For example, 5 943 000 000 is 5.943×10^9 when expressed in scientific notation, and 0.000 083 2 is 8.32×10^{-5} when expressed in scientific notation.