

APPENDIX B

Powers of Ten

The speed of light is 300,000,000 meters per second. The radius of the hydrogen atom is 0.000000000053 meters. Large and small numbers like these appear frequently in the study of physics. Dealing with all of those zeros can be confusing and always requires frequent checking to avoid errors.

To alleviate these problems, a shorthand notation has been developed for powers of ten. The basic idea is to express large numbers in terms of the number of times you need to multiply them by ten and small numbers in terms of the number of times you need to divide them by ten. For example, the speed of light can be written as:

$$3 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \text{ meters/second}$$

That is, multiply 10 by itself 8 times then multiply that number by 3 and you have the speed of light in meters per second. Powers, $10^2 = 10 \times 10$, $10^3 = 10 \times 10 \times 10$, and so on, allow us to rewrite this long expression as 3×10^8 meters/second.

Likewise, we can obtain the radius of the hydrogen atom by dividing 5.3 by 10 a total of 11 times. Because negative exponents indicate division, the radius can be expressed as 5.3×10^{-11} meters.

The following are examples of numbers expressed as powers of ten:

$$10^{-8} = 0.00000001$$

$$10^{-6} = 0.000001$$

$$10^{-4} = 0.0001$$