

Solving Science Problems Step-by-Step

This brief paper outlines a procedure you can follow to solve a wide variety of scientific problems using the math skills you have already learned.

First, as with any word problem, be sure that you understand what the problem is asking you to do. You may need to read the problem over a couple of times or make a drawing in order to find out how what you are given and what you are asked to find are related.

Second, make a list of which quantities you know and which you are being asked to find. Be sure to include units (m, meters; s, seconds; g, grams; etc.) on all quantities that have them. Also, choose a symbol to represent any unknown quantity. For example, consider the following problem from astronomy:

A hydrogen atom emits light with a frequency (f) of 4.568×10^{14} cycles/s. What is the wavelength (λ) of this light? Does it lie in the visible spectrum (4.00×10^{-7} m/cycle to 7.00×10^{-7} m/cycle)?

- What we know: f , the frequency of the light = 4.568×10^{14} cycles/s
- What we want to find: λ , the wavelength of the light, which has units of m/cycle.

Third, thinking back over the relationships between these quantities you have learned in class or your reading, write down an equation that relates them. In this case, for example, we remember that:

$$c = f\lambda$$

Here, c is a constant that represents the speed of light: 2.998×10^8 m/s.

Fourth, using your knowledge of algebra, rearrange this equation so that the unknown quantity you want is by itself on the left-hand side. In our example, if we divide both sides by f we have:

$$\frac{c}{f} = \frac{f\lambda}{f}$$

Then, because the f cancels on the right-hand side we can write:

$$\frac{c}{f} = \lambda$$

So, rewriting with λ on the left-hand side:

$$\lambda = \frac{c}{f}$$

It is usually easier to solve an equation for the unknown before you substitute in any numerical values.

Fifth, substitute the known quantities and constants into the rearranged equation. Be sure to include units on all of the quantities that have them.

$$\lambda = \frac{2.998 \times 10^8 \text{ m/s}}{4.568 \times 10^{14} \text{ cycles/s}}$$

Sixth, calculate the value of the unknown by performing the indicated operation(s) first on the numbers *and* then on their units. This last part is very important. Dividing the numbers in this example is easy (assuming that you know how to work with numbers in powers-of-ten notation on your calculator), but you also need to divide the units which, in this case, are fractions. Dividing the numbers, you have:

$$\lambda = \frac{2.998 \times 10^8}{4.568 \times 10^{14}} = 6.422 \times 10^{-7}$$

Note that we have rounded our answer to four places because c and f were each only given to four places. Now, treat the units as algebraic variables and divide the first fraction by multiplying it by the reciprocal of the second. Because seconds (s) cancel when you “flip” the fraction in the denominator, you have:

$$\frac{\frac{\text{m}}{\text{s}}}{\frac{\text{cycles}}{\text{s}}} = \frac{\text{m}}{\text{s}} \times \frac{\text{s}}{\text{cycle}} = \frac{\text{m}}{\text{cycle}}$$

Finally, write your final answer by putting the number and unit parts back together:

$$\lambda = 6.422 \times 10^{-7} \frac{\text{m}}{\text{cycle}}$$

Seventh, in addition to stating the numerical answer and its units check to see if there are any other questions you need to answer based on your calculation. In this example, because $6.422 \times 10^{-7} \text{ m/cycle}$ is between $4.00 \times 10^{-7} \text{ m/cycle}$ and $7.00 \times 10^{-7} \text{ m/cycle}$, you conclude that: “Yes, this light emitted by the hydrogen atom does lie in the visible spectrum.”