25.2: Advice on Calculations

Substituting Numbers

When faced with solving an algebraic equation to obtain a numerical answer, solve the equation symbolically first and then substitute numbers. For example, given the equation

$$ax^2 - b = 0 \tag{25.2.1}$$

where a = 2 and b = 8, first solve for x,

$$x = \pm(b/a)^{1/2} \tag{25.2.2}$$

and then substitute the numerical values:

$$x = \pm(8/2)^{1/2} = \pm 4^{1/2} = \pm 2 \tag{25.2.3}$$

This procedure is far better than substituting numbers first,

$$2x^2 - 8 = 0 \tag{25.2.4}$$

and then solving for x. Solving first and then substituting has two advantages: (1) It is easier to make algebraic manipulations with symbols than it is with numbers. (2) If you decide later that numerical values should be different, then the entire solution procedure doesn't have to be repeated, only the substitutions at the end.

Significant Digits

In numerical calculations, keep only one additional digit beyond those present in the least accurate input number. For instance, if you are taking the square root of 3.4, your calculator might tell you that the answer is 1.843908891. The answer you write down should be 1.84. Keeping all ten digits of the calculator's answer gives a false sense of the accuracy of the result.

Round the result up if the digit following the last significant digit is 5 or greater and round it down if it is less than 5. Thus, the square root of 4.1, which the calculator tells us is 2.049390153, should be represented as 2.05 rather than 2.04.

Changing Units

It is easy to make mistakes when changing the units of a quantity. Adopting a systematic approach to changing units greatly reduces the chance of error. We illustrate a systematic approach to this problem with an example in which we change the units of acceleration from meters per second squared to kilometers per minute squared:

$$\begin{aligned} 5\ \mathrm{m/s^2} &\rightarrow 5\ \mathrm{m/s^2} \times (0.001\ \mathrm{km/m}) \times (60\ \mathrm{s/min})^2 \\ &= 5 \times 0.001 \times 60^2\ \mathrm{km/min^2} \\ &= 18\ \mathrm{km/min^2} \end{aligned}$$

The trick is to multiply by the conversion factor for each unit to the power that makes the original unit cancel out. The conversion factors to the proper powers are then multiplied by the original number and the proper cancellations of the old units are double checked. If done with care, this yields the correct result every time!

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