

## 0.5: Problem Solving and Thinking About Your Answers

### Learning Objectives

- Students will learn a method for numerical problem solving that they will use throughout the modules.

In learning science, you will be practicing your critical thinking and problem-solving skills. To aid you as you develop your skills, we have created a set of guidelines. One thing to keep in mind if you get frustrated is that some problems are complex and are supposed to take a long time to answer. Be patient with yourself, and go through problems methodically, step by step. Write everything out in the space provided, and keep careful notes of all measurements, calculations, and ideas. It is okay to brainstorm if you do not know where to start. The goal is for you to come to your own understanding of the material.

A step-by-step process that we will use for numerical problems will help guide you through such problems in a systematic way. We suggest always writing down the following steps in the space provided (at a minimum) and we will provide examples throughout the modules for you. The steps include:

- Given: Write down the information you are given, including the symbols for variables, their values, and what they mean.
- Find: Write down the information you are trying to find, including the symbols for variables, their values, and what they mean. What is the goal?
- Concept(s): Write down any relevant equations, conversion factors, or anything else that you might need.
- Solution: Now that you have set up the problem clearly, you can start plugging in numbers.
- Think about it: Does your answer make sense?

For some problems, you might also want to draw diagrams to help you figure things out. Once you get to the solution stage, you are doing mathematical manipulations. At this stage, two key principles will get you a long way: (1) whatever you do to one side of an equation, you must do to the other, and (2) whatever you do to the top of a fraction, you must do to the bottom (and vice versa). You should also keep careful track of your units. Finally, make sure you know the ins and outs of your calculator, and that you are performing calculations correctly with it.

For all problems, conceptual and numerical, the last step is critical: think about your answer. Does it make sense? For conceptual questions, ask yourself “would my answer make sense if I read it out loud to a friend?” For numerical questions, you can check yourself by making sure the final units make sense and by checking if the number you get is in the ballpark that you would expect. For example, if you calculate the lifetime of the Sun and get 300 seconds, does that make sense to you? Do you need to revisit your calculations? Or, if you keep track of your units and the units come out wrong, you also know you need to revisit the problem. For example, if instead of getting  $3.15 \times 10^7$  s for the number of seconds in a year, you get  $3.15 \times 10^7$  1/sec, , you should return to the problem.

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