6: Problem-Solving Strategies

Much of this course will focus on developing your ability to solve physics problems. If you enjoy solving puzzles, you'll find solving physics problems is similar in many ways. Here we'll look at a few general tips on how to approach solving problems.

- At the beginning of a problem stated in SI units, immediately convert the units of all the quantities you're given to base SI units. In other words, convert all lengths to meters, all masses to kilograms, all times to seconds, etc.: all quantities should be in un-prefixed SI units, except for masses in kilograms. When you do this, you're guaranteed that the final result will also be in base SI units, and this will minimize your problems with units. As you gain more experience in problem solving, you'll sometimes see shortcuts that let you get around this suggestion, but for now converting all units to base SI units is the safest approach.
- Similarly, if the problem is stated in CGS units immediately convert all given quantities to base CGS units (lengths in centimeters, masses in grams, and times in seconds). If the problem is stated in British engineering units, immediately convert all given quantities to base units (lengths in feet, masses in slugs, and times in seconds).
- Look at the information you're given, and what you're being asked to find. Then think about what equations you know that might let you get from what you're given to what you're trying to find.
- Be sure you understand under what conditions each equation is valid. For example, we'll shortly see a set of equations that are derived by assuming constant acceleration. It would be inappropriate to use those equations for a mass on a spring, since the acceleration of a mass under a spring force is *not* constant. For each equation you're using, you should be clear what each variable represents, and under what conditions the equation is valid.
- As a general rule, it's best to derive an algebraic expression for the solution to a problem first, then substitute numbers to compute a numerical answer as the very last step. This approach has a number of advantages: it allows you to check units in your algebraic expression, helps minimize roundoff error, and allows you to easily repeat the calculation for different numbers if needed.
- If you've derived an algebraic equation, *check the units* of your answer. Make sure your equation has the correct units, and doesn't do something like add quantities with different units.
- If you've derived an algebraic equation, you can check that it has the proper behavior for extreme values of the variables. For example, does the answer make sense if time $t \to \infty$? If the equation contains an angle, does it reduce to a sensible answer when the angle is 0° or \(90^{\circ}\
- Check your answer for reasonableness—don't just write down whatever your calculator says. For example, suppose you're computing the speed of a pendulum bob in the laboratory, and find the answer is 14;000 miles per hour. That doesn't seem reasonable, so you should go back and check your work.
- You can avoid rounding errors by carrying as many significant digits as possible throughout your calculations; don't round off until you get to the final result.
- Write down a reasonable number of significant digits in the final answer—don't write down all the digits in your calculator's display. Nor should you round too much and use too few significant digits. There are rules for determining the correct number of significant digits, but for most problems in this course, 3 or 4 significant digits will be about right.
- Don't forget to put the correct units on the final answer! You will have points deducted for forgetting to do this.
- The best way to get good at problem solving (and to prepare for exams for this course) is practice—practice working as many problems as you have time for. Working physics problems is a skill much like learning to play a sport or musical instrument. You can't learn by watching someone else do it—you can only learn it by doing it yourself.