TIPS FOR SOLVING PHYSICS HOMEWORK PROBLEMS

Getting started

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- *Try to develop a picture—something you can visualize—that captures the essence of the problem.* This is especially important for advanced topics in physics. Some problems are easily pictured, whereas others, which involve abstract physical concepts and quantities, require more effort to visualize. *It helps to draw a large, clear, accurate, labeled figure that incorporates everything you know about the problem.* Not only is the figure useful in itself, but drawing it forces you to spend time formulating the problem in your own mind.
- *Use symmetries to simplify your work.* For example, adapt a coördinate system to the problem at hand, or use symmetries to argue that some quantities are zero, thus reducing the number of things you have to calculate.
- *Identify the important scales—i.e., the important quantities with dimensions—before you start.* It makes no sense to say that a physical quantity with dimensions is big or small except in comparison to the relevant scales. Moreover, most physics problems reduce to an exercise in calculating a dimensionless constant that multiplies the relevant quantity with dimensions.
- *Reason backward from the answer you are asked to supply to the concepts and information you need.* Don't just start pulling formulas out of the hat, trying to find one that fits.
- *Guess the answer, using any technique at your disposal, before you begin.* Take advantage of figures, dimensional analysis, etc., before doing algebra. If your guess turns out to be wrong, all the better, because it will make you think about your answer.
- *If you don't need to know the answer exactly (you never really do), think about whether an easier approximate technique can be used.* After you have identified the important scales above, it is often obvious that an approximation is sufficient. Since calculating the exact answer might be impossible or extremely time-consuming, you're wasting your time trying to get an exact answer when an approximation will do.
- *Before using advanced techniques, think whether the problem—or at least part of the problem—can be solved using elementary methods.* Using an advanced method when an elementary one suffices is usually a sign that you don't have a good understanding of the problem.
- *Pause before you start work on a problem to try to think of a clever way to do it.* **There is no credit, in real life or in this course, for doing unnecessary work.** If you can think of a clever, new approach, wonderful! It might be the *only* way to do the next problem. If you can't think of a clever approach, you will at least be reconciled to the required hard work, and you might even understand the problem better.

Doing the problem

- *Don't put in numerical values till the end.* This makes dimensional analysis possible, displays the dependence on all the parameters—particularly that the answer *doesn't* depend on parameters that cancel out—and makes it easy to redo the problem with different numerical values.
- *Always use vector signs on vectors.* An equation with a vector on one side and a scalar on the other doesn't make any sense and shows you don't know what you're doing.

Checking your answer

- *Test your solution in any limiting case where you know the right answer from other considerations.* This is good advice in almost any situation, not just physics problems.
- *Do the problem in two or more independent ways.*
- *Check that your answer has the proper units.*
- *Think about your answer critically, to see if it makes sense in light of other things you know.* If you can't make sense of your answer, then you need to reëxamine your work. If after careful reconsideration, your answer turns out to be correct, then you have learned something important (a physicist would say that you've improved your physical intuition).

Conclusion

- Why are there so many more tips about getting starting and checking your answer than about doing the problem? That's partly because techniques for doing problems are often specific to the problem or to the area of physics. In contrast, the tips for getting started and checking your answer are nearly universal. Thus, in real life the techniques for getting started and checking the answer assume even greater importance. Get used to using them now on relatively well-formulated homework problems.

  Formulating and figuring out how to approach a real-life problem is often quite hard. *Compared to homework problems, real-life problems are usually poorly formulated, and the answer isn't known by anyone* (at least anyone you know; otherwise why would you be doing the problem?). Indeed, what makes real-life problems most difficult is that they are often formulated in a way that prejudices you to take the wrong approach; the key to solving such a problem is to reformulate it. Once the problem is properly formulated, actually doing it often turns out to be a mechanical procedure (albeit it could be a very complicated mechanical procedure). Since any procedure, especially a complicated one, is prone to error, having ways to check the answer is absolutely crucial.