

ASTR430 Handout 1:

Problem Solving Hints

This handout is meant to give you advice to help you improve your problem solving skills and your homework writeups. You should follow these points for ASTR430 homeworks, and you are encouraged to employ them in your other science classes as well. Write up neat homeworks. Take pride in your homework writeups and do the best job that you can on them. Take the time to solve the homework problems roughly on scratch paper, and then copy them over neatly, filling in additional details on your final copy.

- **Show your work.** Give written descriptions of what you are doing, and why you are doing it. This is often especially useful at the beginning of a problem where it will force you to think about the problem physically and formulate your approach mathematically. Descriptions will also maximize the chances that a grader can follow what you have done in a derivation (especially if you go off on a wild tangent!) and will help the grader to give you constructive comments on your work. Give enough detail, and show enough mathematical steps, that students less advanced than you could understand your derivation!
- **Check units.** Any equation that you write must be dimensionally correct. Check your equations occasionally as you go through a derivation. It takes just a second to do so, and you can quickly catch many common errors. Remember this general rule: in all physically valid solutions, the arguments of all transcendental functions (e.g. trigonometric functions, exponentials, logs, hyperbolic functions, etc.) must be dimensionless. Taking the cosine of something with units of mass or length makes no physical sense.
- **Check limits.** Check all of your final answers and important intermediate results to see if they behave correctly in as many different limits as you can think of. Sometimes you will know how a general expression should behave if a particular variable is set to zero, infinity, or some other value. Make sure that your general expression actually displays the expected behavior!
- **Take advantage of symmetries.** Symmetries are fundamental in physics (and astronomy!). Problems can have symmetry about a point (spherical symmetry), a line (cylindrical or axial symmetry), or a plane (mirror symmetry). You can use symmetries in two ways: 1) to check your final answer to a problem; or, with a little more effort, 2) to simplify the derivation of that final answer. As an example, time-independent central forces (like gravity) have spherical symmetry because the magnitude of the force depends only on the distance from the origin. In this case, spherical symmetry means that once we find one solution (e.g. a particular ellipse for gravity), all other possible orientations of this solution in space are also solutions.
- **Use common sense.** Usually you will have some physical insight into how the solution to a problem should look. Compare your derived solution to a problem to what you

expect from physical insight. Trust your instincts! If a derived equation or numerical value looks strange, go back through the derivation and look for an error. If you can't find an error, make a note of your concerns near your final solution so the grader can comment on them.

- **Get help from others.** Work on the homework problems on your own first and get as far as you can on them. This is the best way to improve your problem-solving skills and prepare for in-class tests. But certainly get help from other people (other students, or the prof) when you are stuck! By trying the problems first, you will be able to ask more intelligent questions and better understand the ideas of other students and/or the hints the prof might give.
- **Go over homework solution sets.** When you get homeworks back, go over the solution sets and your corrected homework together. Use the solution set to see how to get past points where you were stuck, and make sure that you could easily do a similar problem if given the chance, say on a midterm. Even if you get a particular problem correct, there is always much to learn by following through someone else's solution, particularly the prof's!