Lab 0 - Problem Solving Techniques Earth 202

Much of what you'll learn in this class will come from solving problems. The idea is to use what we've discussed in class to take the next step in understanding the Earth and planets. Problem solving is how we learn to do science. An old line says "if you think you understand it, and you can't do the problems, you don't understand it." Solving problems often takes time, because it involves more than plugging numbers into a formula. You need to think through the question and try different approaches. Often you'll need to draw on - or review - what you've learned in earlier courses, especially in the math prerequisite courses. Thus don't be embarrassed if some problems take time and effort. The time you spend will pay off in improved understanding and make the tests easier.

Don't put off work to the last minute.

It's not unusual to not know how to solve a problem at first glance. It's a good idea to skim the problem, get an idea of what the question is asking, and think about how the problem may be solved. Thinking about the problem for a while may make solving it later a lot easier.

Read the problem carefully.

Look at the question carefully. Make sure you consider everything the question asks. We have noticed when grading problem sets and lab reports, that many times parts of questions were skipped. Read the directions that tell you what is being looked for. As the old line says "when all else fails, read the directions."

Sketch the problem.

Drawing a sketch often helps. For example, problems about waves being reflected and refracted can be much more easily visualized by drawing the paths that are being taken. Good plots also help you understand the problem and let us understand what you had in mind (e.g., partial credit!).

Decide what is being given, and what is being asked for.

Once you have a picture, you can lay out your plan of approach. What variables have you been given? Do you need more information to proceed to the next step? That may be the unknown you are solving for. A good way to organize your mind is to list the known and unknowns. Write them down first symbolically, and then list the specific values you're using.

Keep track of dimensions.

Most problems involve different physical quantities that are related. For example, since distance = speed x time, finding a wave's speed involves dividing the distance travelled by the time it took. Make sure the dimensions in your proposed solution work. If they don't, find the error before continuing.

Break complex problems into chunks.

More complicated problems may be laid out for you in multiple steps; these will help guide you to the end. Sometimes it is difficult to fully understand what the problem is asking you for and/or what you have at hand to attack the problem. Try to break such problems into understandable, solvable chunks. This would allow you to have a better understanding of different parts of a problem, solve each, and then mentally connect them and look for the missing parts.

Use the math.

Geophysics is a math-heavy field. Frequently, you will need to use math to get you to the answer. Intuition can only get you so far. A math proof will be a much stronger than descriptive explanation (though the former can back up the latter). Don't be afraid to use integrals and derivatives and trig where appropriate, and don't skip steps on math proofs to get to the end. Much like pictures, more work shown can't hurt you.

Check if your answer makes sense.

Are you finished? Check to make sure you've done everything the problem asked. Then check to see if your answer makes sense. See if you can compare your answer to basic rules of physics to confirm they're valid. For example: if you're calculating P and S wave velocities, S waves cannot be faster than P waves. Also check if your answer has velocity units. Check to see if the answer is within a reasonable order of magnitude.

Be careful with units and unit conversions.

Many errors come from converting units. There's a nice discussion on
https://www.youtube.com/watch?v=Xr9L7rZqT34&feature=youtu.be

The trick is to write the conversions explicitly. For example, imagine you have an answer in meters, say 35000 m, and want it in kilometers. Write the equivalence

1 km = 1000 m

and divide both sides to get the conversion factor

1= 1 km / 1000 m

in the form (units you want / units you have).

Then multiply what you have by the conversion factor
35000 m x (1 km / 1000 m) = 35 km
which cancels out the meters, leaving kilometers. To make this work, be sure to write and cancel the units. Then check that the units make sense. For example, seismic velocities have units of speed.

Proof read for significant figures.

Make sure the numbers you give throughout your solutions have proper number of significant figures.

Write clearly and in order.

Try to convey what you have in mind in a clear and orderly way. Clear solutions will help us understand what you're doing.

Don't be reluctant to ask for help.

The instructor and TAs won't do problems for you - then you'd learn nothing - but we're happy to help. You'll get the best response when you contact us after thinking about the problem for a while, have written what's known and what needs to be found, have an initial sketch, and can explain where you're stuck.