How do you solve problems?

Solving problems is only one of the four key tasks we ask our students to perform in introductory physics. Yet it is the one most associated with physics, the one which causes the most anxiety among students, and the one which most often appears on tests and homework.

Problem solving is a skill, one which can be taught and improved with intelligent, correct practice. But problem solving is also a talent which is with us from the day we are born. By the time you get to physics you are already an accomplished problem solver. But the kinds of problems you encounter in physics require a different approach that the ones we encounter in our everyday lives.

Solving a problem contains a number of elements that may pose difficulty to people. First, problems are almost always presented in words and a physical situation is described. Many people find translating this textual representation into a format (pictures and math) more amenable to solution, a tricky task and some will have trouble starting the problem because of this.

After the words have been deciphered the next major challenge is to understand the physics behind the problem. Richard Feynman once made the comment that what students see in the intro course are 1,000 formulas but that we (experienced problem solvers) see 4 ideas.

Start by asking yourself -- What kind of problem is this? Is it a motion problem (dynamics or momentum)? or a force problem? Both have similar approaches since they both deal with vectors. Or is it an energy kind of problem? Now you must look at before and after conditions. Is it a field problem? (vectors again)

But you must first be aware that you are learning different and very powerful approaches. I am sure that you may find it difficult, on a day by day basis while you are intently studying portions of a chapter at a time, to realize that you are actually carving out large chunks of understanding about the physical universe. Step back every few chapters and see where you stand. Is this chapter an extension of the previous one or is a completely new approach? Do the problems have the same feel as the last chapter? What about the problems in the next chapter?

Many textbooks have both Questions and Problems. Questions are conceptual, designed to be addressed without mathematics, and they require considerable thinking. But Problems are math-based and require considerable analysis. This distinction is sometimes useful but always artificial. First approach each problem as though it was a question. Try and get to the key ideas without the mathematical analysis, estimate an answer before you do any calculations. And it's also useful after answering a Question to ask yourself – How can I turn this into a Problem?

And finally you should develop a systematic approach to solving problems. Many inexperienced problem solvers make the mistake of trying to hold the problem completely in their head. That is they will not write anything down until they have the problem solved. This is usually not a good way to go about things. Though this is possible at the level of Exercise problems, which only require plugging a number into a single formula, most problems (even at the intro level) need to be broken into pieces to be solved.

Your text has very useful hints on problem solving (e.g., draw an x-y axis, label all forces, break vectors into x and y components,…). Though this algorithmic approach has its pitfalls it is still a very useful start. By learning a systematic approach you should always be able to begin the problem. I will also carefully model systematic approaches to solving problems during the lecture.

If you ask an experienced problem solver how to do a problem, they may right it down completely and all at once. And a few may actually have solved the problem in a single flash of insight. But most of us apply the same systematic analysis that we are asking you to use. But we just do it much faster because of experience. But as you become more experienced in the problems you will also gain speed and confidence in your analysis.

Finally, the third difficulty is to use mathematics to solve the problems. But that is a separate issue.

Generally then, there are five stages to solving a problem.

- Understand what is being asked.
- Translate the problem into a form easier to analyze than the written word.
- Determine the physics behind the problem.
- Apply a systematic approach to solving a problem.
- Check your answer.

This last stage is vital. Experienced problem solvers always check their answers.

> Do you have the right units? What about the order of magnitude of the answer? Is it about right or completely out of the ballpark? How close does the answer resemble physical reality? What about taking your answer to some limiting case and comparing it to a known problem?

These comments should encourage you to practice good habits while solving problems. Just doing problems is not enough. What you want to do is learn how to solve problems.

Problem Write Up

1. Begin with a short summary of the problem. Write down your understanding of what is being asked. Usually a sketch of the physical situation with the key quantities is a good (almost necessary for many people) thing to have.
2. Use a brief narrative as you solve the problem, i.e., do not simply write down the equations but describe what you are doing and why.
3. Usually you do not plug numbers into the equations until the very end. You work to an algebraic expression then plug the numbers into the expression.
4. Check your answer and then test it for appropriate behavior. (What does this mean?)