

## Solving Problems

One of your goals in taking a physics course is to become more proficient at solving physical problems. In a typical physical problem you are given a description about something that is taking place in the universe and you are supposed to figure out and write something very specific about what happens as a result of what is taking place. More importantly, you are supposed to communicate clearly, completely, and effectively, how, based on the description and basic principals of physics, you arrived at you conclusion. To solve a typical physics problem:you have to (1) form a picture based on the given description in you mind; (2) concoct an appropriate mathematical problem based on the picture; (3) solve the mathematical problem; and (4) interpret the solution of the mathematical problem.The physics occurs in steps 1,2,and 4. The mathematics occurs in step 3. It only represents about 25% of the solution to a typical physics problem. Still, some proficiency in mathematics is very useful for solving physical problems.

Although practice is the most important thing, you may find the following general rules to be helpful.

### Problem–Solving Guidelines

1. **Read the entire problem carefully.** Then read it again to try and find out what you are being told. Don't worry about the question at first; focus more on what information you are being given.
2. Whenever possible, **draw a diagram of the physical situation.** Label the diagram with the information given in the problem. Be sure to include units, such as meters or kilograms, with the quantities. If some standard symbols have been introduced, label the parts of the diagram with them, too. For example, you might label  $r$  for radius,  $h$  for height, or  $l$  for distance. You might also make a list of the known and unknown quantities involved.
3. Only after you are sure you understand what is given and after you have labeled the diagram should you **tackle the question.** It is often a good idea to briefly write down the question, using symbols.
4. The next step is to **find a mathematical relationship between the known and unknown quantities.** For example, if asked how far an auto goes in 2 hours at 30 kilometers per hour, you call on your knowledge of the notion of speed and relation between speed, time and distance. In most cases you will need to write the relationship between the known and unknown quantities in the form of an equation, or perhaps several equations.
5. Next you should **solve the equation, or equations, for the unknown quantity or quantities.** This means rearranging the formulas in accord with the rules of algebra so that you have an equation with the unknown on the left-hand side of the equals sign and all of the known quantities and constants on the right-hand side.
6. Now, and only now, should you **substitute numerical values into the equation.** Do not substitute just “bare numbers,” but substitute both the numerical values *and* the units. Units are multiplied and divided as if they were algebraic quantities. Your answer should then come out in the appropriate units. If the units do not come out correctly, you have probably made some basic error. On the other hand, if the units are correct, there is a higher probability that your work is correct.
7. As a final check you should **consider whether your answer is reasonable.** Does your result have the proper order of magnitude? You may even carry out a quick order-of-magnitude estimate as a way of confirming your work.