

Solving Physical Problems

When you solve a physical problem (that is, a problem of physics, chemistry, meteorology, etc.), you almost always use relations between physical quantities, expressed as mathematical equations, to help you. For example, you might want to use Newton's Second Law to solve a problem of motion, or the First Law of Thermodynamics to solve a problem of energy, or the Ideal Gas Law to solve a problem of the state of a gas.

It takes skill and intuition to use such relations to solve physical problems. To become adept at problem solving, you have to practice, and you have to pay attention to what you do. Studies of good problem solvers find that such people have certain habits that contribute to their success. You can study these habits, and with practice you can make them your own.

(I) Understanding a Relation

Physical relations are tools you wield to help you to solve physical problems. To use tools well, you must know how and when to use them. You must understand them. To understand a relation, you need to attend to the following:

(1) What quantities appear in the relation, what are their dimensions, and what do they mean?

(2) How can you interpret the relation? That is, what does the relation mean physically, verbally, mathematically, graphically?

(3) To what physical situations does a relation apply?

(II) Processing Skills

To solve many physical problems, you must have processing skills. In particular, you need the following:

- (1) to manipulate symbols algebraically;
- (2) to manipulate dimensions and units (also algebraically);
- (3) to manipulate powers of ten; and
- (4) to manipulate numbers arithmetically (that is, calculate).

To avoid confusing yourself when you apply these skills, you should apply them in the order shown here as you work your way through a problem.

(III) Problem-Solving Skills

Once you understand the physical relations you might use, and how to manipulate or process them mechanically, you can practice problem-solving skills. To solve a problem, you must organize your approach to it. The lessons learned from studying good problem-solvers suggest the following approach:

- (1) Describe the problem. Summarize the relevant information, which includes (a) the information given to you; (b) information you want to find; and (c) information that you need to solve the problem and that is not given to you but that you already know (e.g., the values of constants). Define symbols for all quantities.
- (2) Plan the solution. Choose appropriate relations; define symbols for the quantities in those relations; and ensure that the relations connect the information that you know with the information you want to find.
- (3) Implement the plan. Using your processing skills, apply the relations to get a symbolic answer; then evaluate your answer quantitatively (that is, attach numbers to each known quantity and calculate an answer).
- (4) Check that your answer has the right dimensions and units; a reasonable magnitude; and the right sign or direction. This requires that you have some intuition about whether the answer is physically reasonable.