HOW TO SOLVE PROBLEMS

An important element of solving any problem in physics is showing your complete solution, so that every reader understands the logic you followed. I present here several examples of both correct and incorrect presentations of solutions.

First, let's consider a very simple motion problem. The simplest versions of these involve motion in one dimension (straight line motion). Suppose a car travels 100 km along a road in 4 hours. What is the average speed of the car? This is a pretty simple example and you should be able to figure out in your head that the answer is 25 km/hr. How should this look on your homework?

Where possible, you should draw a diagram or figure representing the situation. This will become very important when dealing with forces or with motion in more than one dimension, but in this case, a figure is not absolutely necessary. Then, you should write explicitly the governing equation(s), i.e., the equations that you will use to solve the problem. In this very simple case, we can proceed as:

$$s = v_{av}\, t$$

where s is distance traveled, v_{av} is the average speed, and t is the time elapsed.

Second, solve for the relevant variable, here that is average speed :

$$v_{av} = \frac{s}{t}$$

and finally substitute numbers **and units** to obtain the final answer:

$$v_{av} = \frac{100\ \text{km}}{4\ \text{hr}} = 25\ \text{km}/\text{hr}$$

I would likely post the solution as:

$$s = v_{av}\, t \Rightarrow v_{av} = \frac{s}{t} = \frac{100\ \text{km}}{4\ \text{hr}} = 25\ \text{km}/\text{hr}$$

where the symbol " ⇒ " means "implies".

It is very common for students to submit solutions that look like:

$$100/4 = 25\ \text{km}/\text{hr}$$

I will not give full (or very much credit) for such an answer, even though the correct result appears at the end. In a trivial case like this, it is obvious what equation you are using, but as we do more realistic and complex problems, it will not be. Additionally, there are no units attached to the values on the left; my solution above is an example of what I mean by using units consistently throughout a problem.

Now let' s try a slightly more complicated case. You might have learned in a previous physics course than an object moving in a circular path experiences a centripetal acceleration, whose magnitude is described by:

$$a_{cent} = \frac{v^2}{r}$$

where a_{cent} is the centripetal acceleration, v is the speed, and r is the radius of the circular path. (If you are not familiar with this equation, don't worry, you will be, but for now we are just using for illustrative purposes.) Suppose we have a vehicle that travels at a constant speed along a circle of radius 2 km, completing one lap in 100s. We are not given the speed directly, but we are given enough information that we can solve for it. At this point, most students would compute the numerical speed of the vehicle and then divide by the radius. This is not wrong, but it is not the most efficient or informative (or to use the word mathematicians love, elegant) way to do this.

We find the speed by using:

$$s = v\,t \Rightarrow v = \frac{s}{t}$$

The distance traveled in completing one circular lap is given by the circumference of the circle:

$$s = 2\pi r$$

therefore, we can write the speed as

$$v = \frac{s}{t} = \frac{2\pi r}{t}$$

and the acceleration becomes:

$$a_{cent} = \frac{v^2}{r} = \frac{(2\pi r/t)^2}{r} = \frac{4\pi^2 r}{t^2} = \frac{4\pi^2\,(2000\text{ m})}{(100\text{ s})^2} = 7.9\text{ m}/\text{s}^2$$

Note that my solution uses units throughout, and introduces numerical values only in the last step. This might take some getting used to, but you will find that it eliminates many intermediate calculations (and therefore reduces the number of possible numerical errors you can make.)