3D BE SNUB

Too many students feel that understanding physics means simply being able to "solve" each assigned problem by finding a formula that yields the given numerical answer (on the calculator) when one plugs into the formula the numerical values stated in the problem. Such a process does have modest value in developing skills in formula-reading and algebra and manipulation of a calculator for simple one-step problems, but it fails to develop the insight and ability to deal with more sophisticated situations in a meaningful way.

In order to develop your ability to approach problems logically and systematically, in a manner consistent with physical principles, we will insist that your solutions to assigned problems and advanced tests problems follow a prescribed pattern to be eligible for full credit. At times the patters steps will seem tedious and unduly repetitious, but in your instructor's judgment the payoff will be well worth the extra effort.

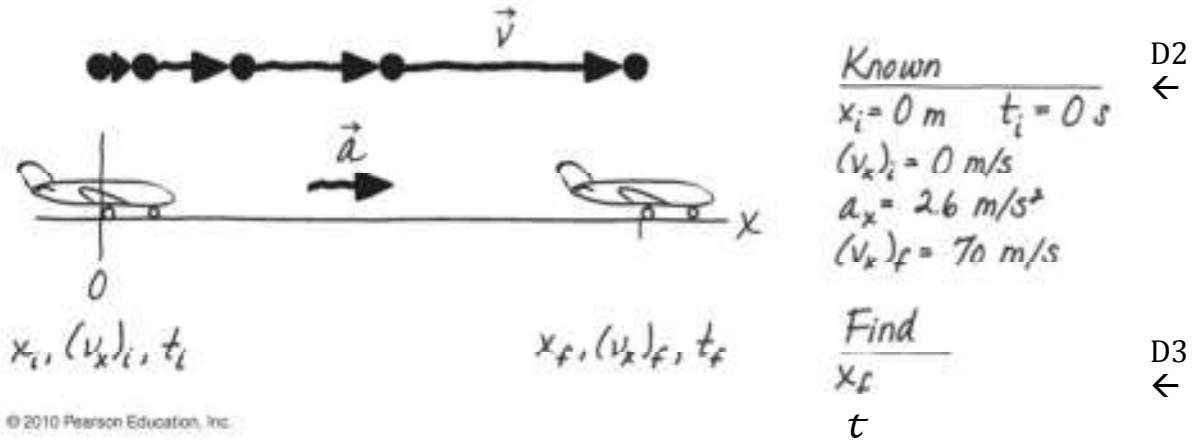
The mnemonic 3D BE SNUB should help you remember the following eight steps in a satisfactory solution:

- D1
  Draw, or sketch, the situation pertaining to the problem, using symbols to represent the various parameters (distances, masses, etc.). In the few cases for which a sketch is not pertinent write: "D1--".
- D2
  Define the known values.
- D3
  Describe (one line will do) what needs to be found in the sketched situation, and any assumptions you feel are necessary to render a solution possible (such as friction is negligible).
- BE
  List the Basic Equations which apply to the situation. Write the equations as they are written in the textbook.
- S
  Derive an explicit Symbolic solution for each desired quantity, using the Basic Equations and the defined symbols. Units are not shown since the symbol represents the defined quantity including its units. This aspect makes the symbols easier to manipulate than the quantities they represent. **This step is the heart of the solution** and does not even involve a calculator!
- N
  Substitute Numerical values, with units, for the symbols representing known quantities to obtain a Numerical solution.
- U
  Check the Units to verify that they are proper and consistent. Do this by dimensional analysis (i.e., reworking the equation with units instead of numbers).
- B
  Check the numerical solution for "**B**allpark" accuracy, i.e., is the answer reasonable? You may indicate that you believe it is by writing a check mark after the "B", or by "B ?" that you have no experience whatever that will relate to the calculated quantity.

If a step is not pertinent put the symbols n/a *(meaning* not applicable*). For example, if no numerical values are given, you would write* "N n/a" *or* "N --" *at the appropriate place.*

Example

A fully loaded Boeing 747 with all engines at full thrust accelerates at 2.6 m/s^2. Its minimum takeoff speed is 70 m/s. How much time will the plane take to reach its takeoff speed? What minimum length of runway does the plane require for takeoff?



	Takeoff Time	Runway Length
BE	$v = v_0 + at$	$x = x_0 + vt + \frac{1}{2}at^2$
S	$v = \cancel{v_0} + at \rightarrow t = \frac{v}{a}$	$x = \cancel{x_0} + \cancel{v}t + \frac{1}{2}at^2 = \frac{1}{2}at^2$
N	$t = \frac{70\frac{m}{s}}{2.6\frac{m}{s^2}} = 26.9s$	$x = \frac{1}{2}\left(2.6\frac{m}{s^2}\right)(26.9s)^2 = 940m$
U	$s = \frac{\cancel{m}/\cancel{s}}{\cancel{m}/s^{\cancel{2}}} = s$	$m = \left(\frac{m}{\cancel{s^2}}\right)(\cancel{s})^{\cancel{2}} = m$

B Having flown a lot, about 27s sounds like a reasonable time for a plane to accelerate on takeoff. Actual runways are closer to 3,000m or more because they have to allow for emergency stops; however, if we had calculated a runway length of longer than 3,000m then we would have known we made some sort of error along the way. Our calculation of 940m is reasonable.