General Problem Solving Steps

This step-by-step guide was adapted from Dr. Dedra Demaree's Ph213 course from the Oregon State University, the University of Minnesota's Physics Education Research page, and the Workshop Physics Activity Guide.

1. **Understand the problem and devise a plan**
   a. **Read and translate the problem statement.** Read the problem carefully. What are the key words? What information is given and what will you need to find? Visualize the situation for yourself, what physically might happen? *Explicitly state what the problem is asking including clarifying the problem statement. For example, if the problem states when will the two cars collide, you can state when will the two cars have the same coordinates for **x** and t.*
   b. **Determine applicable concepts/laws and assumptions/simplifications.** Think what physics concepts/laws are involved (i.e. Newton's 1st Law, Conservation of Energy, etc.) and what assumptions you can make about the physical situation in order to apply those concepts/laws. What simplifications are reasonable: can you ignore the size of the objects and consider them particles? Can you ignore friction? *In your homework you must explicitly state how the assumptions simplify the problem and are consistent with what concepts apply– for example if you are using momentum conservation for the system of two cars in a collision it means you will be ignoring friction from the road since that is an external force and you have simplified the system to no external forces in order to apply a conservation law.*
   c. **Use clear, grammatically correct English as a running narrative throughout each step of the problem.** For example, before doing the algebra, state that you are solving for a certain variable.

2. **Represent the problem physically and mathematically**
   a. **Represent physically.** Translate the text of the problem into an appropriate type of physical representation (this may be a picture, a free-body diagram, an energy bar chart, a ray diagram….). *Record all given quantities in the diagram and identify symbolically (define your symbols!) the relevant variables and unknowns. Choose and show the coordinate axes. For example, a force diagram should have labeled axes, correct force arrows of representative length and direction with defined labels* (i.e. if you label an arrow F_{eb}, you must state that e is the earth and b is the box, or if you label and arrow G you must state that it is the force of gravity acting on the box).
   b. **Represent the concepts/laws mathematically.** Use the physical representation to construct a mathematical representation. Then make a table with all the known and unknown variables relevant to the given situation. List all the equations you will use. Make sure that this representation is consistent with the physical representation (for example, if you define your origin above the ground, an object on the ground will not have zero gravitational potential energy). *You should have a **symbolical** mathematical statement that clearly shows what concept/law you are starting with to solve the problem. For example a 1-d kinematics equation could start with* $x_f = x_o + v_o t + (1/2)at^2$.

3. **Carry out the solution**
   a. **Work through the mathematics.** Use the mathematical relationships from 2b to clearly solve for the unknown quantity (quantities). Make sure you include enough steps that

someone can follow your work and that you use consistent units. If you have set up your problem properly, this step should be purely mathematics. However, you may find yourself stuck and unable to completely solve the problem. In that case, go back and check all above steps to make sure you haven't overlooked some piece of physics implied by the situation, or some known relationship such as the fact that the kinetic friction is proportional to the normal force. **Keep symbols in your solution as long as possible.**

b. **Carry out the calculations** using numbers (with appropriate units and number of significant figures) as the final step.

c. Draw a box around your final answer, and make sure you include **appropriate units and number of significant figures** in your final answer. In theoretical problems (those not using "real measurements"), you can generally expect all quantities you are given to have two or three significant figures.

4. Look back – was your answer as expected, does it make physical sense?

a. **Evaluate the result.** Is the final value you found reasonable? Are the units appropriate? Does the result make sense in limiting cases? Does the result make physical sense? *Include a written explanation for why your result makes sense and what it tells you about what happens in the physical situation. Do not simply state "This makes sense."*