Problem – Solving Skills

1) Quickly read through the problem to determine what is being asked for and circle it.

2) Think through how you will get from the information given to the final answer (or from the reverse direction, or from both forward and reverse directions). For complex, multi-step problems do this one step at a time.

3) In doing step 2, determine which information is important and underline that information. The rest of the information is useless and, consequently, does not need to be read again.

4) Solve the problem, one step at a time.

5) Always check your answer.

6) Do NOT memorize specific algorithms for solving specific types of problems.

   • they only work under very specific circumstances and do not help you solve any other types of problems

   • master the basic concepts

   • do as many problems as possible

   • test yourself by changing the information given in a problem (for example, reverse the problem, that is, starting from the answer can you determine one or more of the pieces of information that was originally given?)

   • after doing the above, you should be ready for whatever the instructor or real world throws at you.

Numerical Problem Solving Restated

1. Identify what you are asked to find. If more than one result is asked for, tackle one at a time.

   You may need to translate words into a specific, calculable item.

2. Visualize the situation, either mentally or on paper. Sketch a diagram, draw molecules, write out chemical reactions, etc. The human mind is much better at manipulating patterns and images than raw number crunching. *Understand* the problem before you attempt to solve it.

3. Identify what you are given to start with. Some items are explicitly given, such as masses or dimensions. Other data may be implied or assumed, such as constants (π or e), common quantities (seconds in a minute, or inches in a foot), units conversion (1 km = 10^3 m = 10^6 mm), and so on.

4. Identify equations that can "bridge" the gap between the given quantities and the desired results. This is perhaps the most difficult step, and one that you will only improve at with practice.

   You will be expected to build and draw from an encyclopedia of relationships or equations. Some may be new to you, such as the equations for density ($\rho=m/V$), while others should be common knowledge at this stage of your education, for example the area of a circle ($A=\pi r^2$).

   Which equations are important in this course? The best answer is the equations which are numbered in your textbook (for example, see pages 22 and 24).

   When considering which equations apply, don't forget to use algebra. Do not hesitate to manipulate a given equation to form one more suitable to your problem. For example, you learned that $\rho=m/V$ (determine density when mass and volume are known). You can rearrange this to solve for mass when density and volume are given ($m=\rho V$), or volume when density and mass are given ($V=m/\rho$). Algebra is your friend- don't be afraid to use it!

5. Solve the equation(s) identified in Step 4.

   Remember that when you only have one equation, you can only solve for one unknown. For example, if you want to solve for density (your "unknown") using the equation $\rho=m/V$, you must know the values of m and V. If you don't know m or V directly, you may have enough information to determine them in an intermediate calculation. The mass m could be the difference between the masses of a full and empty container, while the volume V of a container could be calculated using standard geometric formulae.

6. Remember that the result of your calculation(s) is more than just a number, it represents a physical quantity, and as such has three aspects: magnitude (the value you calculate), precision (the number of significant figures used to express your result), and units (the dimensions of your answer). There are quantities you will come across in chemistry that have no units; such values are referred to as "unitless" or "dimensionless" quantities.

7. What the book says: Check the "Reasonableness" of your result:

   Did you answer the question?
   Are the units consistent?
   Is the magnitude reasonable?
   Does your result make chemical sense?