

Unit Analysis and Problem Solving Script

In this video we will discuss two valuable tools for understanding chemistry questions. These are unit analysis and systematic problem solving. Both of these are generally applicable to quantitative problems but are extremely useful for chemistry questions.

Unit Analysis is a method of arranging problems using the units of given quantities as conversion factors. Using unit analysis to set up problems is important because it is an efficient way to minimize errors in a multi-step calculation. Solving problems with this method provides the units for the final answer, and an easy to follow solution. All chemical calculation problems should be solved using unit analysis. To layout a problem with unit analysis, string together a series of multiplication or division calculations. Include units with every quantity, until arriving at the desired set of units for your solution. To make sure your problem is set up correctly cancel out intermediate units before doing the actual calculations. When you are confident your problem arranged correctly, calculate your answer. For example, we can easily determine the number of seconds in a week using unit analysis.

In this question start with the known quantity, one week, then multiply by known conversion factors. For example there are seven days in one week, write the conversion factors as fractions multiplied together, even if you think it is unnecessary, problems will grow in complexity and it is easy to mix up a conversion. The conversion factors we need to solve this problem are: seven days in one week, 24 hours in one day, sixty minutes in one hour, and sixty seconds in one minute. After we have arranged the calculation, make sure the units cancel.

If you need to review fraction multiplication and division be sure to read through the math review section before continuing. Essentially, since we have set this problem up as a series of fraction multiplications and divisions, the units in the numerators of the fractions are divided by the units in the denominators of the fractions, this means a unit in the numerator of the calculation cancels out if the same unit is in the denominator somewhere in the calculation.

In our problem all of the units cancel out, except seconds. Since seconds is our desired answer, we have set the problem up correctly and can continue with our calculation. There are 604 800 seconds in one week. Seconds in per week is a straight forward conversion. Let's look at a different question.

This question demonstrates that unit analysis is an invaluable tool for solving problems. In a two liter bottle of soda there are four servings, each serving is five hundred

milliliters and there are two hundred calories in one serving, how many calories are in a two liter bottle of soda?

To answer the question you can easily multiply 4 servings by two hundred calories. However, now that we have learned unit analysis we can set the problem up using units. There is more than one correct method to solve this problem, either method will yield the desired answer of 800 calories per bottle. The most efficient technique is to multiply four servings per bottle with two hundred calories per serving. You could also multiply the conversion factors: two liters per bottle, one thousand milliliters per liter and two hundred calories per five hundred milliliters. This is a relatively simple question, but it highlights that using unit analysis will be an asset to solving problems, especially as calculations become long and intricate.

There is one more skill we need to discuss before beginning to tackle chemical calculations, and that is problem solving. There are a number of ways that a problem can be solved, this video presents a general six-step method for solving problems.

The first step to problem solving is to identify what is being asked, read the problem carefully. Visualize what is being asked, draw pictures if required. The next step is to identify and organize the given information in the problem, Step three is to identify what information is missing and organize it, find the constants and data required, and list any equations that may be required. Step four is to map out how you are going to solve the problem, what process is required to solve the problem, how do equations need to be manipulated? Use unit analysis to organize the solution. In step five the answer is calculated by following the carefully mapped out solution, keep track of units and round appropriately using significant figures, finish your calculation by writing a concluding statement. The final step in this method is to check your answer, is this a reasonable solution? Make sure the answer to your problem makes numerical and logical sense.

Let's apply these steps to a problem. Christopher drives to work and then back home, round trip he travels 40.0 km. Christopher's car gets 12.8 km for every liter of gas. If Christopher drives to work 5 days a week how much will it cost him in gas each year? Assuming the price of gas stays at \$0.95 a liter, it is not a leap year, and Christopher does not take a vacation.

The problem is asking for the cost of gas paid by Christopher every year. The units for the solution will be dollars per year. What information is provided by the problem? The distance is 40.0 km/day the cost of gas is \$0.95/L the amount drive time is 5 days/week and the efficiency of the car is 12.8 km/L. What information is missing from the problem? In addition to the given information we will need the conversion factor there are fifty two weeks per one year. We are now able arrange a solution, remember we are looking for the units dollars per year, so the units must work out to dollars in the numerator, and year in the denominator. We are now ready to calculate the answer,

round to the correct number of significant figures and write a concluding statement. It costs Christopher \$ 771.90 per year for gas to travel to work. Let's consider this answer, is it reasonable, \$ 771.90 may seem like a small amount of money to pay for gas for the entire year, however, the distance Christopher drives to work is not far. This solution is reasonable.

This concludes our unit analysis and problem solving video, by now, you should be comfortable using unit analysis to solve problems, and have a solid approach to problem solving. After watching this video be sure to complete the chemical math section of the module to practice unit analysis, problem solving and formula manipulations that you will require to be successful completing chemical calculations.