Tutorial – Unit Cancellation Conversion Grid

(file in Std 3)

The most common form of mathematics used in chemistry is what I refer to as the **Conversion Grid**. Many textbooks refer to this as **unit cancellation**. Simply stated, this is a form that allows you to convert from any unit of measure to another, grams to moles, moles to atoms, grams to milligrams, liters to milliliters, moles of one compound to moles of another compound in a balanced chemical equation, and **ON AND ON ! ! !** The nice thing about this grid is that it works for everything except temperature conversions, and allows you to convert problems involving many steps all at one time. Will use this until June! It looks like this:

starting fraction _____ ending fraction_____

It looks like a table, or an Excel Spreadsheet. That is true. Now for an example of how to use it.

Example:

Convert a density of 11.34 g/ml to kg/cm^3 .

Solution:

1. Our first job is to figure out the starting units of measure. The problem stated that you are given a density fraction of g/ml (the starting fraction) and you must end with a density fraction of kg/cm^3 . Let's jump right in and enter our starting and ending fractions:

starting fraction: **11.34 g/ml** ending fraction: **kg/cm^3**

Now you have to find equalities that will bridge the gap from your starting units of measure to your ending units of measure. You will need two equalities for this problem:

1,000 g = 1 kg This equality will take care of the top of our starting fraction, the mass in the numerator of the fraction. It allows us to change **g** to **kg**.

1 ml = 1 cm^3 This equality will take care of the bottom of our starting fraction, the volume in the denominator of the fraction. This allows us to change **ml** to **cm^3** .

Now we can enter our fractions into the grid. Our first fraction is what we were given (starting fraction & number). Let's convert the grams (g) to kilograms (kg).

starting fraction: **11.34 g/ml** ending fraction: **kg/cm^3**

this 2nd box makes the new unit of measure kg/ml

11.34 **g**	1 **kg**			
1 **ml**	1,000 **g**			

But, but, but what? How did you convert anything? Patience ! ! ! You will see. The important thing to notice at this step is that the kg is on top and g is on the bottom. That is because in our starting fraction g is on top, and we want it to be kg at the end, so we put kg on top. Any time we have an equality, when we make a fraction it is the same no matter which is on top. So, **we always put the unit of measure we are going to on the same level as the unit we want to change!** For now, take the rest on faith!

Our next job is to convert milliliters (ml) to cubic centimeters (cm^3). Notice that ml is on the bottom. That is where we need to have cm^3. Remember, **we always put the unit of measure we are going to on the same level as the unit we want to change!** So we put cm^3 on the bottom of this one.

starting fraction: **g/ml** ending fraction: **kg/cm^3**

11.34 **g**	1 **kg**	1 **ml**		
1 **ml**	1,000 **g**	1 **cm^3**		

Well, we've done it ! But, but, but it doesn't look like we're done to you? That's right. We're not really done. There is more, but it is fairly easy now. We've done the hard part. Now we look for units of measure we can "cancel" out (which is what some textbooks use as the basis for calling this a **unit cancellation method**). This is very similar to the following situation:

$$\frac{5\,\cancel{A}}{3\,B} \times \frac{7\,C}{2\,\cancel{A}} = \frac{5}{3\,B} \times \frac{7\,C}{2} = \frac{35\,C}{6\,B}$$

Are you starting to see what our grid is? Yes ! It is a series of fractions all multiplied by each other. So, here is what we do – look for same unit of measure across the top and cancel with same unit of measure across the bottom. I will do this in steps for you:

starting fraction: **g/ml** ending fraction: **kg/cm^3**

11.34 ~~g~~	1 **kg**	1 ~~ml~~		
1 ~~ml~~	1,000 ~~g~~	1 **cm^3**		

I found the g on top and on the bottom, so I could "cancel" out the g on top with the g on the bottom, but not the numbers in front of them. Now for the next cancellation:

starting fraction: **g/ml** ending fraction: **kg/cm^3**

11.34 ~~g~~	1 **kg**	1		
1	1,000 ~~g~~	1 **cm^3**		

Now you can see the only unit of measure left on the top is **kg** and the only unit of measure left on the bottom is **cm^3** .

The last step is to multiply the numbers on the top side by each other and put the final number and its unit of measure in the last cell. Likewise, for the bottom we multiply all the numbers on the bottom side by each other and put the final number and its unit of measure in the last cell. Here we go:

starting fraction: **g/ml** ending fraction: **kg/cm^3**

11.34	1 **kg**	1		**11.34 kg**
1	1,000	1 **cm^3**		**1,000 cm^3**

Notice, the results of multiplying across the top and bottom are in the last cell to the right.

The last thing we have to do to complete our conversion is to divide the number in the top cell by the number in the bottom cell. Then we get this answer:

Ans **0.01134 kg/cm^3**

I admit, this does seem like a lot of work for a fairly simple conversion. But remember, you won't have to recopy the grid the way I did. You just go through the steps one at a time in the same grid. You may be pretty smart or perhaps overly confident and try to do these conversions in your head. **CAUTION !!!** **If you choose to do it in your head, you'll probably get it wrong half of the time**.

MR. WIGGER'S SALES PITCH

The biggest mistake many students make is to try to work things out in their heads. The reason you get problems wrong doing that is because you will always be wondering, do I divide or multiply by 1,000 when I change grams to milligrams? When you're taking a quiz or a test, you are under pressure. If you use my method, you'll never miss ("guess wrong") unless you put the numbers into your calculator wrong ! ! !

Here's the really good news, it doesn't get any more difficult when the conversions are longer and require 5 or more steps. So, **"bite the bullet"**, do it my way from the beginning. You'll be glad you did and you'll be thanking me all year if you do. This same method works for almost everything we do throughout the course. It works for any conversion except for temperatures. That is because in converting temperatures you need to add or subtract in addition to multiplying.