

Factor-Label Problem Solving Method (a.k.a. Dimensional Analysis)

During the course of this year you will be required to solve many types of problems that involve units. Often, you will be required to change from one unit to another. This is not actually very hard, because it is something that you do in your day-to-day life. For example, the running time of a movie may be listed as 90 minutes. You could convert that to hours using a **conversion factor**. A conversion factor is an expression for the relationship between units. In this case you would be using the relationship 1 hour = 60 minutes. You can set up a factor-label problem as shown below:

Step 1. Write down the “given” amount.... what you start with from the problem.

90 min

Step 2. Multiply by a fraction.

90 min x _____

Step 3. On the top and bottom of the fractions, insert the UNITS that are needed to cancel out the “given” unit, and the new unit you want.

hr ← this is the unit you want

90 min x _____

min ← this is the unit you are cancelling

Note that minutes **MUST** go on the bottom in order to cancel. If you put minutes on top, you would get squared minutes! So when you decide which unit goes on the top and which goes on the bottom, look to see which way it will be so that the units cancel, and the new one that you want remains.

Step 4. Insert the numbers in the fraction so that the top of the fraction is EQUAL to the bottom of the fraction. This fraction is called a conversion factor. Since both top and bottom are EQUAL, it doesn't change the amount. It only changes the units in which the number is expressed.

$$90 \text{ min} \times \frac{1 \text{ hr}}{60 \text{ min}} = ? \text{ hrs}$$

Make sure that top and bottom are EQUAL! Don't put down that 1 minute = 60 hours!

Step 5. Make more conversion factors if needed. Sometimes you don't know a conversion between two units. So you break it down into smaller steps. For instance, you may not know how many minutes are in a year, but you do know how many minutes are in an hour. And, you know how many hours are in a day. And, you know how many days are in a year. So instead of making it complicated, we use a series of conversion factors that we know for sure. More about this step later.

Step 6. Cancel units where you can, and solve the math.

$$90 \cancel{\text{ min}} \times \frac{1 \text{ hr}}{60 \cancel{\text{ min}}} = 1.5 \text{ hrs}$$

Of course, most of us can do the above calculation in our heads. This is because we are very familiar with the units and the conversion factors involved. Not all conversions will be that easy, but if you follow the steps correctly, there should be little chance for mistake. If the units cancel out properly, there is a very high chance you will get the problem correct. There are only 2 ways it could go wrong: 1) you enter it wrong into your calculator; or 2) the top and the bottom of the fraction are not equal. Yes, this seems like a lot of extra trouble to do a problem that is so easy. The intent here is to show you how to use this method on easy problems first so we can do more complex problems later. It takes some time and some effort, but it will greatly reduce your mistakes!

You try this one, but you MUST use factor-label method!

If you trade \$32 for quarters, how many should you get?

Let's check your work.

$$32 \cancel{\text{ dollars}} \times \frac{4 \text{ quarters}}{1 \cancel{\text{ dollar}}} = 128 \text{ quarters}$$

Dollars is the unit on the bottom because it cancels the "given" unit that we started with. Quarters is the unit we want to remain, so it's on the top. 4 quarters are equal to 1 dollar. So 4 goes on top with the quarters, and 1 goes on the bottom with the dollar. We see that the units cancel, which means we have the problem set up correctly. Then, do the math. 128!

Now, do the worksheet.