CHAPTER 4

How To Work Problems

Have you ever tried to work some problem and multiplied two numbers when you should have divided one number by the other? Or perhaps you divided "a" by "b" when you should have divided "b" by "a." It would be nice to have some kind of a system which would prevent making such mistakes. The "units method" of working problems is such a system. If you learn the simple rules of the game it is possible to work fairly complicated problems, and still be sure that you have not made any mistakes such as multiplying by a number when you should have divided by it.

THE IDEA OF "UNITS." Many problems involve the conversion of, say, inches to feet, of square feet to square yards, of grams to pounds, etc. These words are the "units" of the particular numbers. In the conversion factor 12 inches = 1 foot, the units of 12 are "inches," and the units of 1 are "feet." In the conversion factor 1 avoir. oz. = 28.35 grams, the units of 1 are "avoir. oz." and the units of 28.35 are "grams."

HOW TO CHANGE A CONVERSION FACTOR INTO A RATIO. In order to work a problem by the "units method," the conversion factor must first be changed into a ratio. Thus, the conversion factor 12 inches = 1 foot must be written as either:

$$\frac{12 \text{ inches}}{1 \text{ foot}} \quad \text{or as} \quad \frac{1 \text{ foot}}{12 \text{ inches}}$$

Likewise, the conversion factor 1 avoir. oz. = 28.35 gm. must be written as either:

$$\frac{1 \text{ avoir. oz.}}{28.35 \text{ gm.}} \quad \text{or as} \quad \frac{28.35 \text{ gm.}}{1 \text{ avoir. oz.}}$$

Any of the conversion factors listed in the Appendix of this book can be converted into similar ratios.

HOW TO USE CONVERSION RATIOS IN A PROBLEM. Now let's work a simple problem. How many inches are there in 16 feet? Of course you know that you must multiply 16 by 12 to get the correct answer, but let's see how you would do this by the "units method." First you write down the number which is *not* a conversion factor. In this case it is 16 feet. Note this is not just 16. It is 16 *feet*. Then you multiply this by one of the two conversion ratios which convert feet to inches or the reverse. All you have to do is to pick the conversion ratio which will cancel out "feet," and leave the answer in "inches." In this case, the proper conversion ratio is $\frac{12 \text{ in.}}{1 \text{ ft.}}$ and the problem is set up as follows:

$$(16 \cancel{\text{ft.}}) \left(\frac{12 \text{ in.}}{1 \cancel{\text{ft.}}} \right) = 192 \text{ in.}$$

The "ft." of 16 ft. is on the "top side," or the numerator, while the "ft." of 1 ft. is on the "bottom side" or the denominator. So they cancel one another just the same as 4 divided by 4 would cancel out. The only units which remain are 'in.," and so the units of the answer are inches.

If we had tried to work the problem as follows:

$$(16 \text{ ft.}) \left(\frac{1 \text{ ft.}}{12 \text{ in.}} \right)$$

then the "ft." would not cancel out since both of them are in the numerator. And we would know at once that we had picked the wrong conversion ratio.

Let's try one more simple problem. How many pounds are there in 5000 grams? To solve this, we must know the conversion factor between lb. and gm. Looking in the Appendix we find 1 lb. = 453.6 gm. This factor can be converted into the ratios $\frac{1 \text{ lb.}}{453.6 \text{ gm.}}$ and $\frac{453.6 \text{ gm.}}{1 \text{ lb.}}$

To get the "gm." of the 5000 gm. to cancel out, we must use the first of these ratios, and the problem is set up as follows:

$$(5000 \cancel{\text{gm.}}) \left(\frac{1 \text{ lb.}}{453.6 \cancel{\text{gm.}}} \right) = 11.03 \text{ lb.}$$

In this case, the use of the units method has proved that 5000 must be divided by 453.6 in order to get the correct answer.

Note that you always multiply by these conversion ratios but if one of the numbers, such as 453.6 in this case, is in the denominator of the conversion ratio then you must divide by this number in order to get the proper answer.