Math Diversion 1062

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> You may have to fight a battle more than once to win it.
> — Margaret Thatcher

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1 Problem

Gold is 19 times heavier than water. Copper is 9 times heavier than water. In what ratio should they be mixed so that the alloy is 15 times heavier than water?

2 Solution

This is a fairly simple mixed-rate problem. Let's start with a figure.

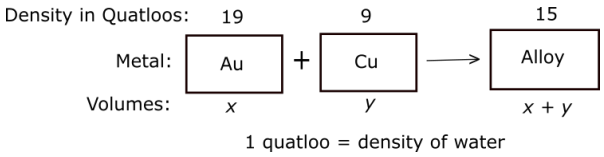

Figure 1. We are tasked with finding the ratio of x to y. In that effort, we don't need to know the actual density of water. Hence, the introduction of the word 'Quatloo' – a metasyntactic variable.

Wikipedia defines a *metasyntactic variable* as a meaningless word used as a placeholder in computer science, but I see no reason not to use them here as well.[1] So I introduced the term *quatloo* as a metasyntactic variable to stand for the density of water, which the problem does not require us to know its actual

[1] At least in Scheme, *our* meaningless words can have units.

value to obtain the requested answer. Computer scientists don't use the word 'quatloo'; they use words like 'foo' or 'foobar'. The word 'quatloo' comes from an episode of the original Star Trek series to mean some unknown amount of currency of some unknown alien race on the planet Triskelion.

So why is all this off-topic nonsense of relevance to this problem? First, we've solved so many similar mixed-rate problems that this is the *most* interesting aspect to this problem. Second, before you start to solve any problem, it's important to know just how much of the given information is relevant and in what form the given information is relevant.

In this problem, we needed to know that the units of gold and copper were in densities. But both the densities of gold and copper were given to us in the same way, yet all we need to know in the end is the ratio of gold volume to silver volume, which is a pure number, and can't possibly depend on the density of water. If you need more convincing, imagine recasting the given densities of gold and copper in terms of multiples of the density of aluminum or of liquid nitrogen. It just doesn't matter.[2]

Anyway, our equation for conserving mass across the alloying process is

$$19x + 9y = 15(x + y)\,. \tag{1}$$

The solution to this system is $x : y :: 3 : 2$.

[2]In fact, introducing the actual density of water (or whatever is being used in its place) could introduce round-off error into the calculation.