# Math Diversion 1002

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> Thermodynamics is Nature's way of balancing
> entropy with enthalpy.
> — Rafael Jaramillo

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Source: http://www.theproblemsite.com/problems/high-school-math
    /2008/mixture-problem
Title:  A Mixed-Rate Problem
 Presenter: Patrick
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## 1 Problem

A man had a 10-gallon keg of wine and a jug. One day, he drew off a jugful of wine and filled up the keg with water. Later on, when the wine and water had got thoroughly mixed, he drew off another jugful and again filled up the keg with water. The keg then contained equal quantities of wine and water. What was the capacity of the jug?

## 2 Solution

We begin with the reasonable assumption that the jug has less volume than the keg. Now, to the figure.

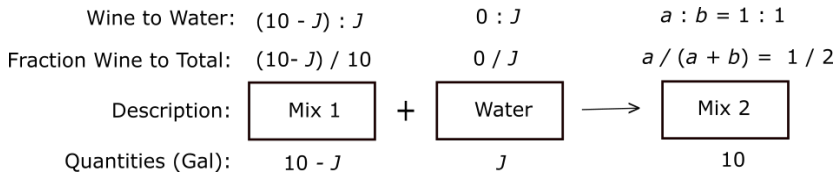


Figure 1. Because both wine and water are treated as conserved, we can balance on either one of them.

Let's balance on wine in this 'before and after' process:

$$\frac{10-J}{10}(10-J)+\frac{0}{J}J=\frac{1}{2}10\,. \tag{1a}$$

From this we get the quadratic in $J$:

$$(10-J)^2=50\,, \tag{1b}$$

which has the solution consistent with our assumptions,

$$J=5(2-\sqrt{2})\approx 2.93 \text{ [gallons]}. \tag{2}$$