

Math Diversion 1101

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June 4, 2026

Questions are keys to door of truth.

— Charlie Chan

Source: <https://www.basic-mathematics.com/hard-word-problems-in-algebra.html>

Title: Word Problem 8.

Presenter: Patrick

1 Problem

One ounce of solution X contains only ingredients a and b in a ratio of 2:3. One ounce of solution Y contains only ingredients a and b in a ratio of 1:2. If solution Z is created by mixing solutions X and Y in a ratio of 3:11, then 2520 ounces of solution Z contains how many ounces of a ? [Also, find the ratio of a to b in Z.]

Solution

a to b ratio:	2 : 3		1 : 2		$u : v$
Fraction of a in total:	$\frac{2}{5}$		$\frac{1}{3}$		x
Solution:	x	+	y	\longrightarrow	z
ounces:	$3y$		$11y$		2520
Amount of a in sol'n:	$\frac{2}{5}(3y)$		$\frac{1}{3}(11y)$		$2520x$

Figure 1. We don't know yet what the value of y is, but when X and Y are mixed together, the result will be in ratio $3y : 11y = 3 : 11$.

First, the information about the number of ounces of X and Y is irrelevant, so we will ignore it. Second, we make a diagram (above). Third, the solving order is first y , then x , then u and v .

We can easily solve for y by utilizing the conservation of ounces in the mixing:

$$3y + 11y = 2520, \tag{1}$$

which give us $y = 180$.

Now, utilizing the conservation of ounces of substance a in the mixing, we get:

$$\frac{2}{5}(3y) + \frac{1}{3}(11y) = 2520x, \quad (2)$$

or

$$x = \frac{180}{2520} \left(\frac{6}{5} + \frac{11}{3} \right) = \frac{73}{210}. \quad (3)$$

Therefore, the number of ounces of a in Z is

$$2520x = 2520 \frac{73}{210} = 876. \quad (4)$$

Lastly, we're asked to find the ratio of a and b in Z, which is represented by the ratio $u : v$ in the diagram. But,

$$x = \frac{u}{u + v} = \frac{73}{210}. \quad (5)$$

Now, if we let $\lambda = v/u$, then this last equation becomes

$$x = \frac{1}{1 + \lambda} = \frac{73}{210}. \quad (6)$$

Solving this for λ yields

$$\lambda = \frac{137}{73}, \quad (7)$$

from which we get that

$$u : v = 73 : 137. \quad (8)$$