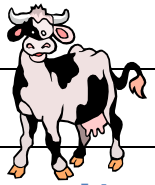
How much Cream?



Whole milk from dairy farms arriving at a Milk Plant is separated into Cream and Skim milk.

Task: How much cream and skim milk will be produced from 100 litres of milk?

Prior knowledge: Simultaneous equations of 2 unknowns. Extension: grouping/ factorising.

A separator is a centrifuge (it spins the milk and the fat which is heavier moves to the outside and is collected and the skim milk is taken from the middle)

The process:

What remains constant? (Mass Balance)
The volume. (the volume in and out must be the same)
The milkfat. (the quantity of milkfat in must equal the milkfat out)

VOLUME: if W = the volume of whole milk in (litres), C = volume of cream out(litres),, S= volume of skim milk out (litres), then

W = C + S (litres)

FAT : Fat in = Fat out

0.03W = 0.4C + 0.008S (litres)

Hence we have two equations, given W = 100 litres for this task we have the following simultaneous equations

100 = C + S

3 = 0.4C + 0.008S Solving these from 100L of Whole milk we get 94.4L skim milk and 5.6L cream.

Extension:

In engineering most formulae are general, so it is sensible to use variables for quantities,

Such as V_w = Volume of Whole milk, V_c = volume of Cream, V_s = Volume of Skim milk
And x_w = % milkfat in Whole milk, x_c = %milkfat in Cream, x_s = %milkfat in Skim milk

Task: Find a formula for the V_s, the volume of Skim milk produced from whole milk.

Equations:

$V_w = V_c + V_s$

$x_w V_w = x_c V_c + x_s V_s$ .....knowns are the whole milk in V_w, and the milk fat%'s ; x_w , x_c, , x_s

Resulting formula: $V_s = V_w(x_c - x_w)/(x_c - x_s)$……this result requires "grouping" or factorising the V_s terms.