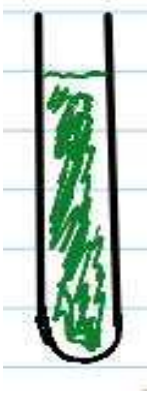
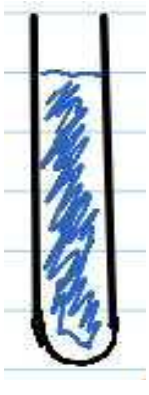
Dilutions Help

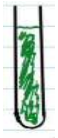
Let's say we had a test tube with a sample (Green) that was at a 3.0 M concentration. And we had a test tube with some water.



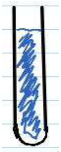


Sample Water

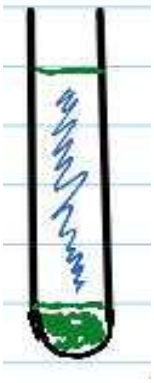
If we took 1 mL of Sample and place it in a new tube, and then added 4 mL of water and then mixed.



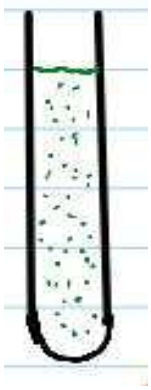
1 mL or 1 volume



4 mL or 4 volumes



mix->



We have just made a dilution. The total volume is 5 mL (or 5 total volumes). To calculate the dilution factor (df) we divide the total volumes by the volumes of sample.

1 volume Sample
+ 4 volumes water
5 volumes total

(d.f.) dilution factor

d.f is then : $\frac{\text{total volumes}}{\text{sample volume}} = \frac{5}{1} = 5$

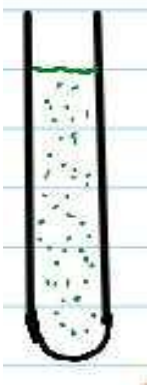
Now you may hear different terms to express this dilution as:

"The dilution factor is 5"
"It was a 5 fold dilution"
"It was diluted 1/5"

These all mean the same thing. There is 1 volume part of sample and 4 volume parts of whatever liquid is being used to dilute the sample for a total of 5 volume parts.

CALCULATING THE CONCENTRATION

To calculate the concentration of our diluted sample we multiply by the inverse of our dilution factor .



initial conc. $\times$ $\frac{1}{\text{d.f.}}$ = Final concentration

3.0 M $\times$ $\frac{1}{5}$ = 0.60 M

CALCULATING THE UNDILUTED CONCENTRATION

Often we wish to work backwards. Let's say we had a sample that had been diluted 1/5 that has a concentration 0f 0.60 M. What was its undiluted concentration?

diluted concentration $\times$ d.f. = undiluted concentration

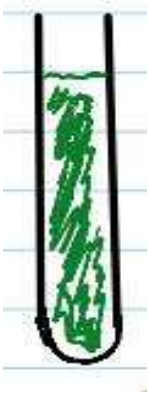
If it was diluted $\frac{1}{5}$,
It has a dilution factor of 5

Therefore we take our concentration and multiply by our dilution factor.

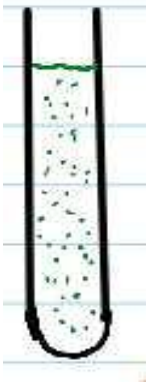
$0.60\ M \times \frac{5}{1} = 3.0\ M$

Multiple Dilutions

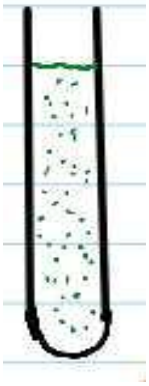
Let's say we took our sample (3.0 M) and diluted it by taking 1part of the sample and adding 4 parts water. That's a 1/5 dilution.



Dilution 1/5



We know that the diluted concentration would be 0.60 M from above. What is the concentration if we take 1 part of this 0.60 M solution and add 3 parts water? (1+3=4 total parts) In other words, a 1/4 dilution.



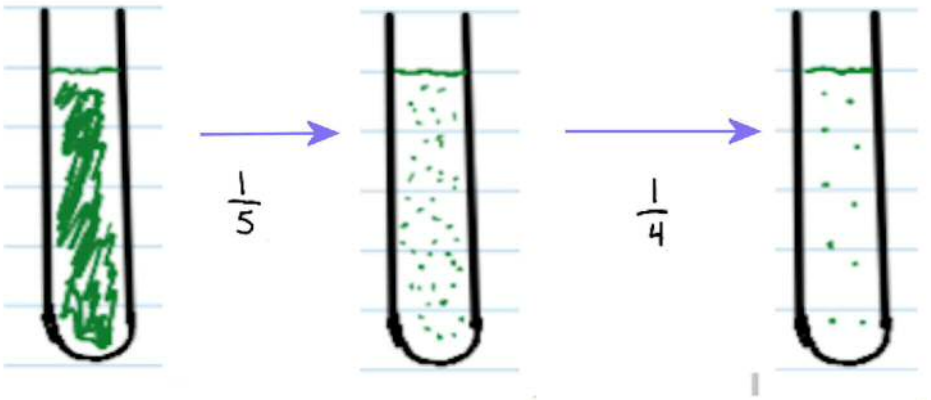
Dilution 1/4

? concentration

If it was diluted 1/4
It has a dilution factor of 4

$$0.60\,M \times \frac{1}{4} = 0.15\,M$$

But we can also calculate this another way.



$$3.0\,M * \left(\frac{1}{5} * \frac{1}{4}\right) =$$

$$3.0\,M * \frac{1}{20} = 0.15\,M$$

By doing two dilutions, our final dilution ends up being a 1/20 dilution. In other words our sample has been diluted 20 fold. (d.f. = 20)

This means that in this diluted sample, there is 1 volume part sample to 19 volume parts of water for a total of 20 parts.

Let's work backwards now. If our diluted sample was 0.15 M and it had been diluted 20 fold - what was its undiluted concentration?

$$0.15\,M * \frac{20}{1} = 3.0\,M$$

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Remember: We don't always dilute samples with water ... we may instead use a buffer solution to dilute or perhaps some other solvent.

Though the terms used are different, ... this concept isn't new. Remember $C_1V_1=C_2V_2$?