# Dilution

**Preparation of a less concentrated solution from a more concentrated one.**

*The more concentrated solution is usually called the STOCK SOLUTION.*

- *remember that the concentration changes when a solution is diluted but the total mass and number of moles of solute remain the same (it is just contained in a greater volume of solution)*

# Dilution

In many labs certain chemical solution are used frequently and are kept available.

However, the exact concentration of solution required may differ from one experiment to another.

The usual practice is to have the solution available in a higher concentration ....

... this is called the STOCK SOLUTION

When you need a particular concentration of this solution for an experiment you simply have to dilute the stock solution.

# Dilution

It is VERY IMPORTANT to not contaminate the stock solution.

You NEVER put a pipette into the stock solution vessel; you pour what you need into an intermediate vessel, say a small flask, and take what you want from there.

# Dilution

*Dilution is adding more solvent; total moles of solute remains constant, they are just contained in a greater volume of water (or other solvent).*

Remember Molarity = moles per Litre

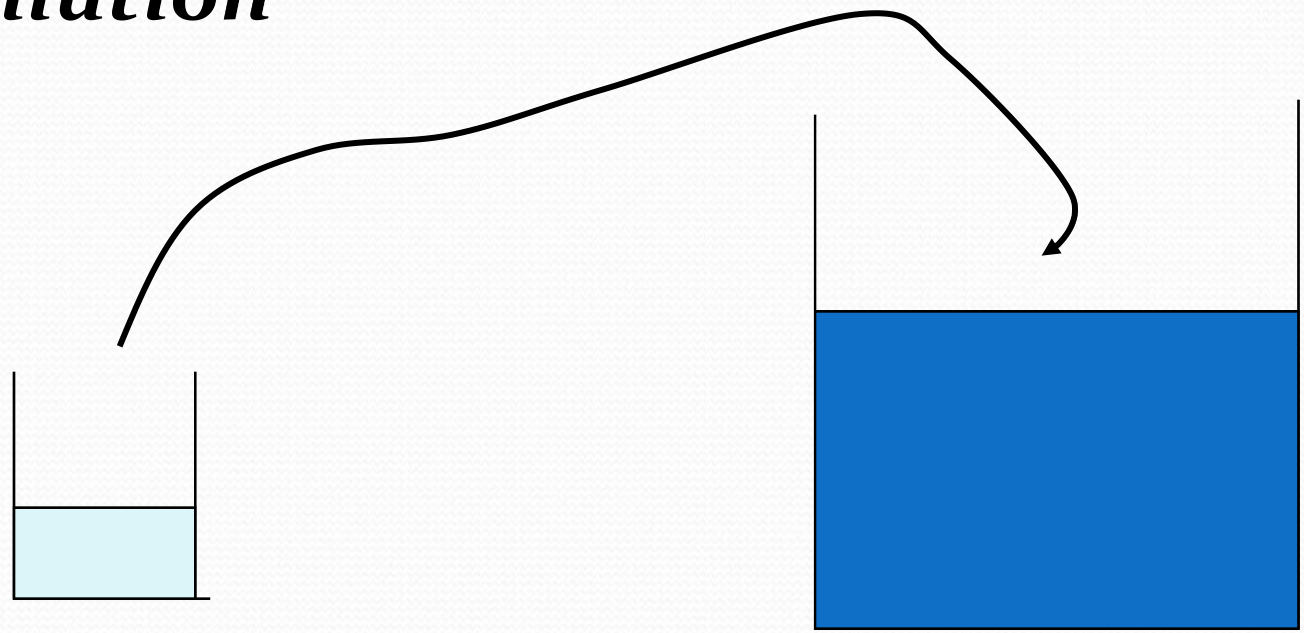
Number of moles in one litre = M

Number of moles in V litres = M x V

When we do a dilution, the number of moles remains the same - we just increase the V and that decreases the M.

# Dilution of Stock Solution

***moles before dilution = moles after dilution***



$V_1$

$M_1$

$V_2$

$M_2$

$$\mathbf{M_1V_1 = M_2\,V_2}$$

# Dilution of Stock Solution

***moles before dilution = moles after dilution***

- $M_1 V_1 = M_2 V_2$

$M_1$ : Molarity before dilution

$V_1$ : volume before dilution

$M_2$ : Molarity after dilution

$V_2$ : volume after dilution

Note: Sometimes we write: $C_1V_1 = C_2V_2$

# Dilution - Example

*If 0.040 L of a 5.00 M solution of copper nitrate $Cu(NO_3)_2$ is diluted to a volume of 0.325 L by addition of water. What is the molarity of the resulting diluted solution?*

---

$$M_1 \times V_1 = M_2 \times V_2$$

$$0.040 \times 5.00 = M_2 \times 0.325$$

$$M_2 = \frac{0.040 \times 5.00}{0.325}$$

$$= 0.615\ M$$

# Dilution - Example

*What volume of 0.12 M HBr can be prepared from 11 ml of 0.45 M HBr?*

$$M_1 \times V_1 = M_2 \times V_2$$

$$0.45 \times 11 = 0.12 \times V_2$$

$$V_2 = \frac{11 \times 0.45}{0.12}$$

$$= 41.25 \text{ mL}$$

# Dilution – example

*Example: You need 100 mL of 1.0M HCl and you have 5.0M stock. What volume do you take from stock to make up to 100 mL?*

---

$$M_1 \times V_1 = M_2 \times V_2$$

$$5.0 \times V_1 = 1.0 \times 100$$

$$V_1 = \frac{1.0 \times 100}{5.0}$$

$$= 20 \text{ mL}$$

Need to take 20 mL of stock solution and add it to 80 mL of distilled water.

# Procedure for doing a Dilution

*Previous example:* ______________________________

1) Get ready: 100 mL volumetric flask, 50 mL and 100 mL graduated cylinders, 20 mL and 5 mL pipette, 5.0 M HCl, DI water
2) ) Using 100 mL graduated cylinder, transfer approx. 70 mL de-ionised water into volumetric flask.
3) Transfer roughly 20 mL (slightly more) HCl from the stock container to graduated cylinder.
4) Transfer 20 mL of HCl from graduated cylinder to pipette.
5) Transfer the 20 mL HCl from the pipette to volumetric flask (Allow 15 s for pipette to empty; don't tap/squeeze …the pipette is calibrated to account for the drop that will be left behind in it). Agitate. Allow to cool slightly.
6) Q.S. with DI water, using a clean pipette.

# Classifications of Water

- 1. Tap Water: Only for washing glassware. Too many mineral impurities for making solutions.
- 2. Laboratory Grade Water: this is distilled or de-ionized water (ions of minerals removed). This is ok for making buffers.
- 3. Reagent Grade Water: Distilled more than once. Also has impurities removed by filtration process. Good for making reagents.
- 4. Ultrapure Grade Water: Distilled and endotoxin free.

# Stock Solutions

- In many labs, or for a particular set of experiments, certain solutions are used frequently.
- To minimize the volume occupied by these solutions, they are made up at higher concentrations than will be required for most experiments. These are called the stock solutions.
- When an experiment requires this particular chemical – at some other (lower) concentration – a portion of the stock solution is taken and diluted as required.
- It is VERY IMPORTANT not to contaminate a stock solution. NEVER PUT ANYTHING into its container – no pipettes, nothing. Always ***pour*** some stock solution into another clean empty container, and then take what you need of it from there.

# Dilution Ratios

This is another method to work out how much of a stock solution to use to prepare a required concentration of final solution.

- You know molarity of stock (concentrated) solution.
- You know molarity of (diluted) solution required.
- You know volume of diluted solution required.

- Get ratio of diluted to concentrated molarity.
- Write in simplest (fraction or decimal) form.
- This same ratio should be the ratio of stock solution to diluted solution (i.e. this is the fraction of the final volume that should be stock solution).

# Dilution Ratios

Since: $M_1 V_1 = M_2 V_2$

$M_2/M_1 =$ fraction (dilute molarity/ stock molarity)

$V_1 / V_2 =$ same fraction (fraction of final volume that is from stock)

Work out: $M_2 / M_1$ .. *This will be number less than 1*

Multiply $V_2$ by this number

This is now the volume $V_1$

# Using Dilution Ratios

Example:

What volume of 5.0M $CaCl_2$ stock solution is required to make up 25 mL of 0.5M $CaCl_2$ solution?

Molarity ratio: 0.5 / 5.0 = 0.1 (= 1/10)

Therefore 0.1 (1/10 th) of final volume must be stock solution

i.e. 0.1 x 25 mL (1/10 of 25 mL) = 2.5 mL

To make:

25 – 2.5 = 22.5 mL is volume of water.

Transfer 2.5 mL stock from pipette into volumetric flask.

Add 22.5 mL water to volumetric flask (approx 10 mLs, shake, then add the remainder with pipette).

# Using Dilution Ratios

Example with acid:

What volume of 7.5 M HCl stock solution is required to make up 450 mL of 0.5 M HCl solution?

Molarity ratio: 0.5 / 7.5 = 0.06666

Therefore 0.0666 of final volume must be stock solution

i.e. 0.0666 of 450 mL = 30 mL

To make: 450 – 30 = 420 mL is volume of water.

Put 400 mL water in volumetric flask.

Add 30 mL stock acid from pipette into flask.

Q.S. with water using a clean pipette.

# Serial Dilutions

If you start with a concentrated stock solution and dilute it, then take some of that diluted solution and dilute it again, then take some of the diluted, diluted solution and dilute it again etc. etc. you are doing a serial dilution.

This is a quick and easy way to prepare a solution of a very low concentration from a stock that is quite concentrated. It might not be possible to make the required low concentration solution directly, in one dilution step, because the amount of stock solution needed might be too small to measure out.

# Serial Dilutions

Example:

You have a 5.0 M stock solution and you require 20 mL of 0.0005 M solution. What volume of stock solution must be used?

$M_1 \times V_1 = M_2 \times V_2$

Where $M_2$ and $V_2$ is molarity and volume of dilute solution, say.

Therefore volume of stock solution required is

$V_1 = (M_2 \times V_2) / M_1$

$= (0.0005 \times 20) / 5 \quad = 0.002$ mL

This amount of stock solution might be too small to measure out.

# Serial Dilutions

Serial dilutions are particularly suited for preparing cell suspensions, because these suspensions are usually too concentrated to dilute in one step.

Sometimes you might want a <u>set</u> dilute solutions of different concentrations.

The unit for concentration of cell suspensions is: cells/ mL.

But the formula works the same way:

$$C_1 \text{ x } V_1 = C_2 \text{ x } V_2$$

Where the C stands for concentration (in place of molarity)

# Serial Dilution

Each dilution is the same as the previous one i.e.. if your first step is to half the stock solution concentration, then the next step is to half it again etc. etc.

Or if your first step is to make a solution which  is 1/10$^{th}$ the concentration of the stock solution then the next step is to make a solution which is 1/10$^{th}$ of that again etc.

First dilution: $1/x$

Second dilution: $1/x^2$

Third dilution: $1/x^3$

etc

# 1/10 Serial Dilution

$C_1 \times V_1 = C_2 \times V_2$

If $C_2 / C_1 = 1/10$

Then $V_1 / V_2 = 1/10$

Decide on a volume (must be same) that you will want of each diluted solution.

You will need to make a larger (slightly larger) volume than this (say 20% more), because you will draw from each to make the next dilution.

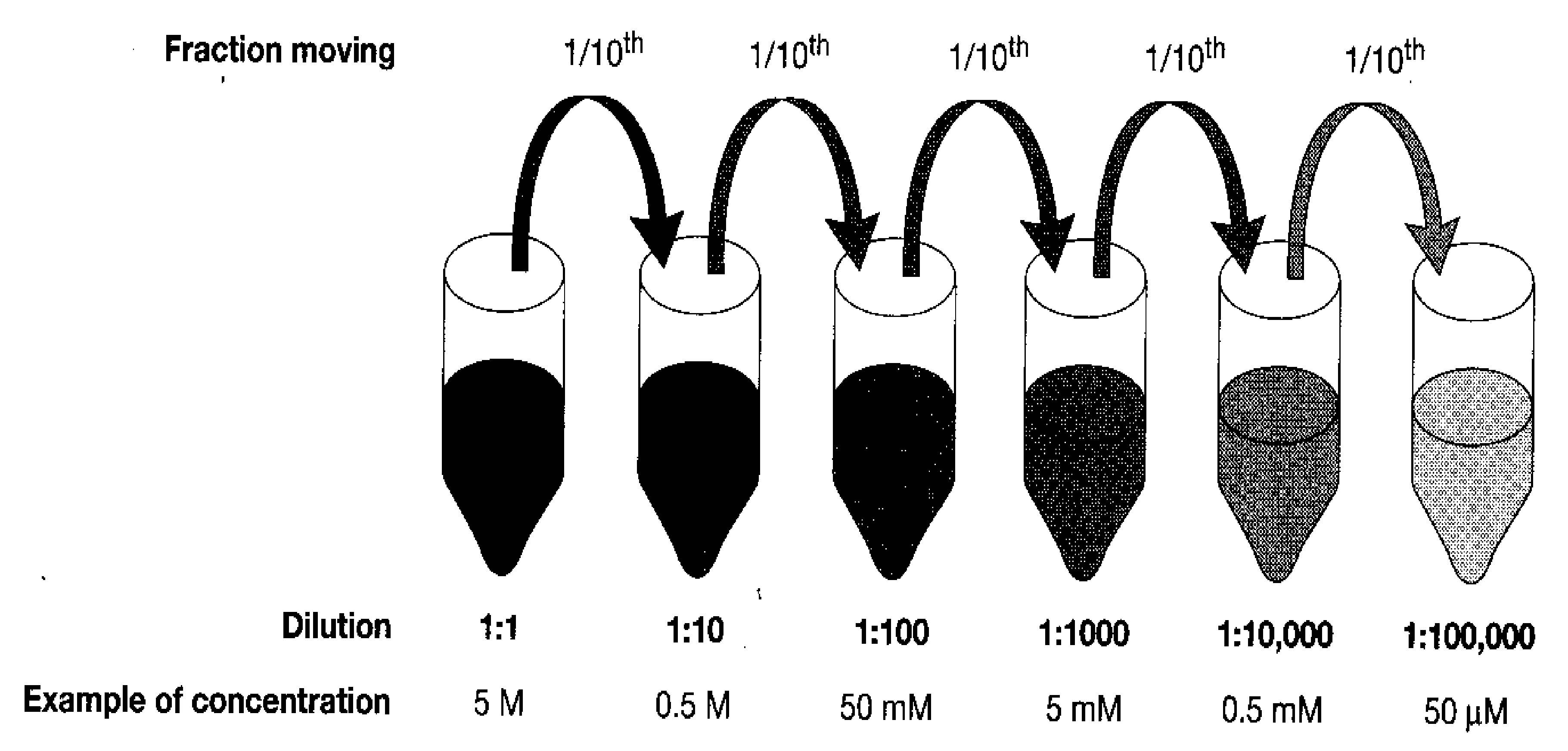
(*You might be doing an experiment where you want the intermediate solutions)*

# Doing a Serial Dilution

- Line up a row of containers.
- Put 9/10th of ‘volume-you-are-making ‘ of solvent into each container.
- Take 1/10 of volume-you-are-making from the stock solution and dispense into container 1.
- Take this same volume from container 1 and dispense into container 2 etc. etc

# 1/10 Serial Dilution

Example:



# 1/2 Serial Dilution

$C_1 \times V_1 = C_2 \times V_2$

If $C_2 / C_1 = 1/2$

Then $V_1 / V_2 = 1/2$

Decide on a volume (must be same) that you will want of each diluted solution.

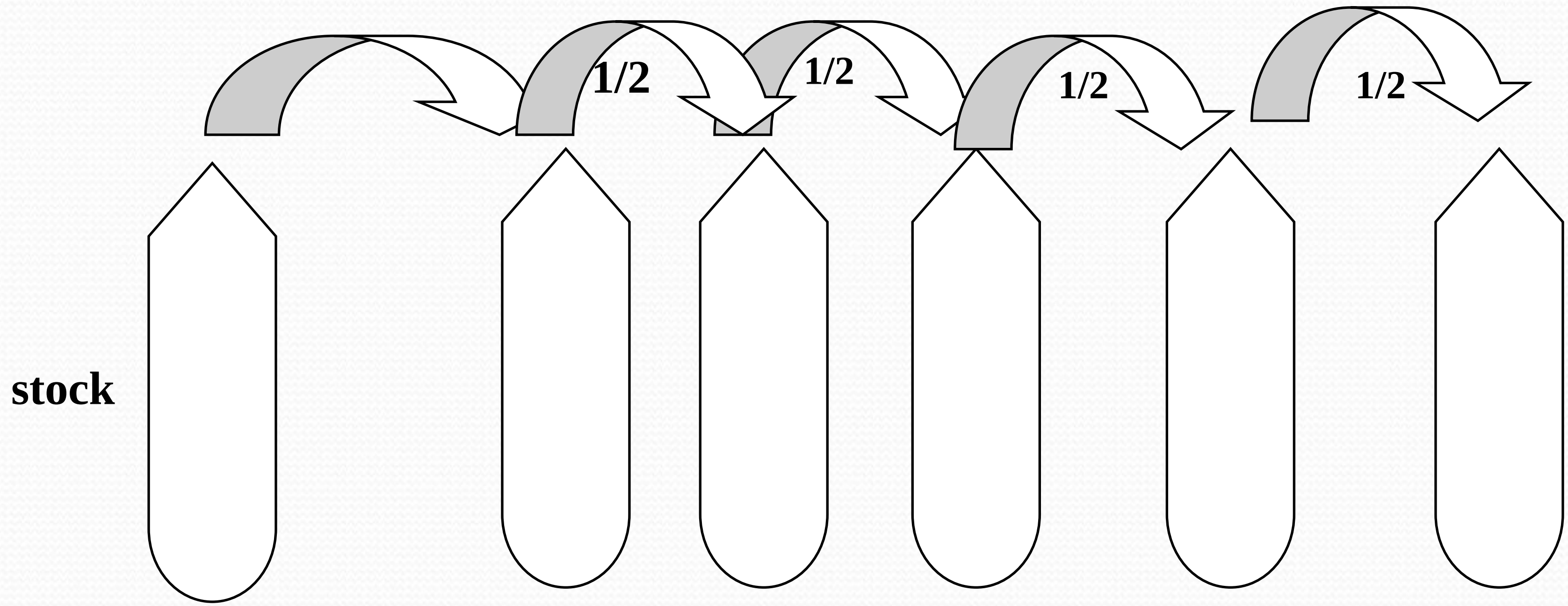
You will need to make a larger volume than this (double ), because you will draw from each to make the next dilution.

# Doing a ½ Serial Dilution

- Line up a row of containers.
- Put the 'volume-you-are-making' of solvent into each container.
- Take the 'volume-you-are-making' from the stock solution and dispense into container 1.
- Take this same volume from container 1 and dispense into container 2  etc. etc

# 1/2 Serial Dilution

Container: 1 2 3 4 5




Dilution: 1:1 1:2 1:4 1:8 1:16 1:32

Conc. 80 40 20 10 5 2.5

(ppm)