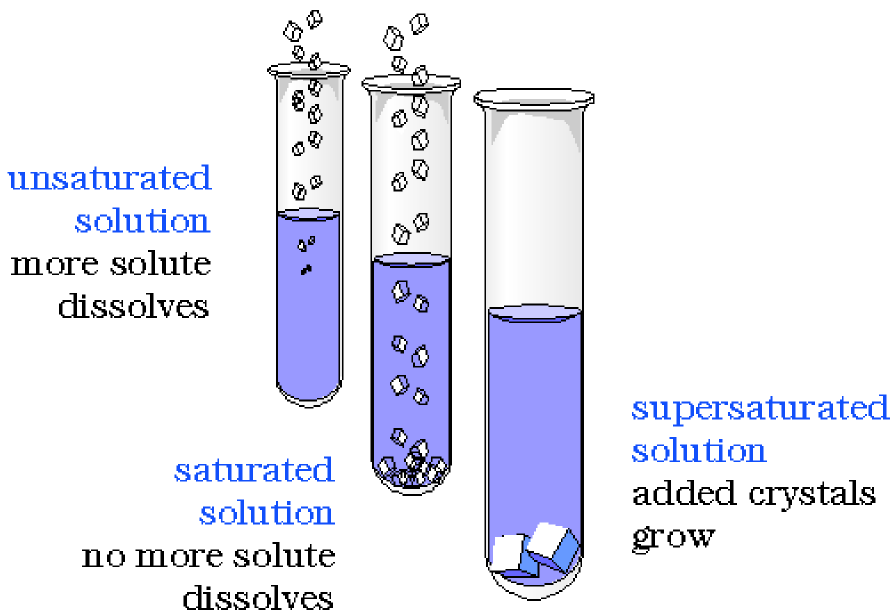
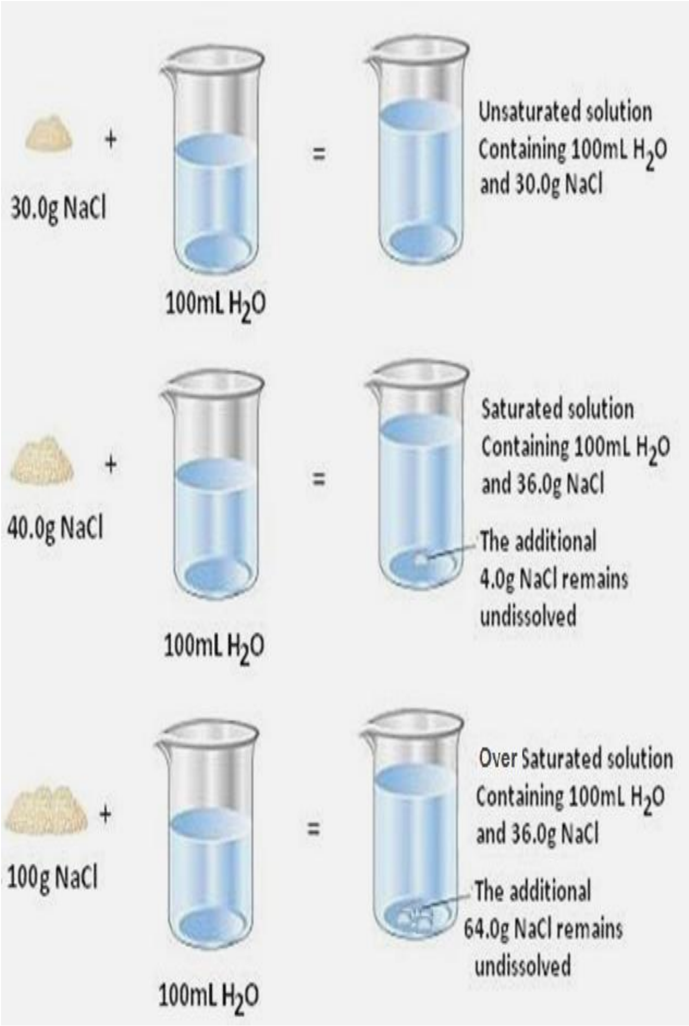
Concentration Based on Degree of Saturation



Saturation Degree

- **Unsaturated Solution**
  - less than the maximum amount of solute for a given temperature is dissolved in the solvent.
  - There is more available space for solute to dissolve in the solvent
  - **No solid remains in flask.**
- **Saturated solution**
  - Is one where the concentration is at a maximum - no more solute is able to dissolve **(you begin to see some crystals)** at that temperature.
  - A saturated solution represents an *equilibrium*.
- **Supersaturated**
  - Solvent holds more solute than is normally possible at that temperature.
  - You can see a **big amount of solute at the bottom of the flask**



Percent Saturation

- Proteins are often purified by differential precipitation with salts ,such as ammonium sulfate. The salt conc. used to “salt out“ proteins is always expressed in the terms of **percent saturation**

- It is the concentration of salt in a solution as a percent of the maximum concentration possible at a given temperature.

$$V\ (ml) = \frac{100\ (S_2 - S_1)}{1 - S_2}$$

  - **V** is the volume of the saturated salt needed.
  - **S1** is the initial low saturation (used as a decimal).
  - **S2** is the final high saturation (used as a decimal).
  - **This is to the volume to be added to 100 ml at saturation S1.**

Example

- **How many ml of a saturated ammonium sulfate solution must be added to 40 ml of a 20% saturated solution to make the final solution 70% saturated?**

Given values:

S1= 20% = 0.2 ,S2= 70% =0.7

$$V\ (ml) = \frac{100\ (S2-S1)}{1-S1} = \frac{100\ (0.70 - 0.20)}{1 - 0.70} = 166.6\ ml$$

(**according to the formula**, this is to the volume to be added to 100 ml at saturation S1)

100 ml → 166.6 ml

40 m → ?

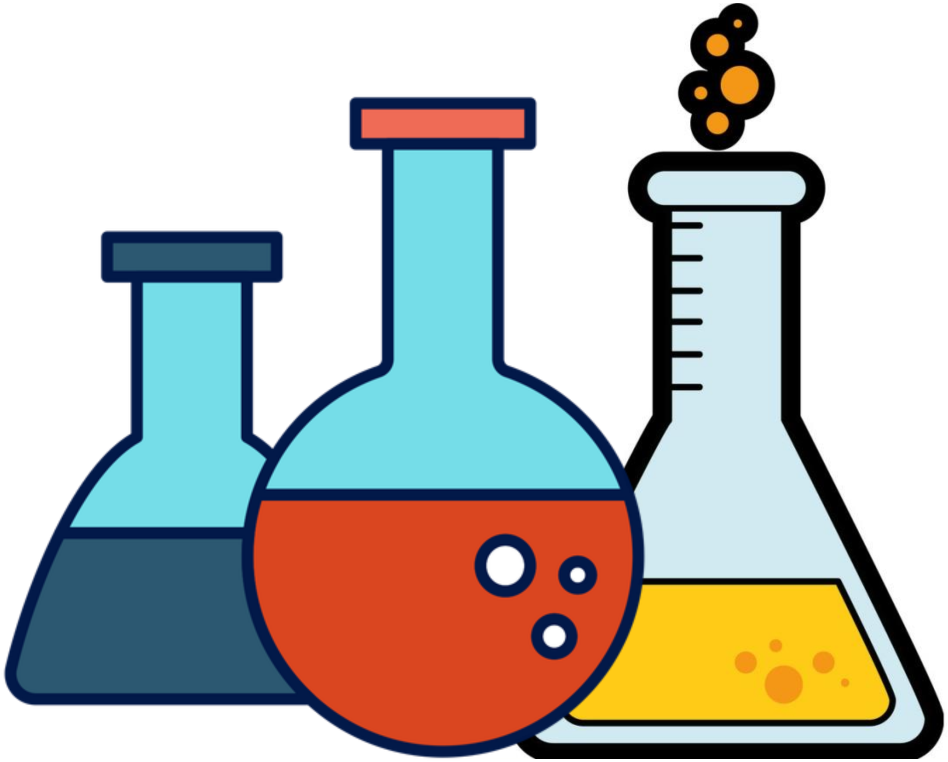
$$\text{The volume needed} = \frac{40 \times 166.6}{100} = 66.6\ ml$$

Units Conversion

Prefix	Symbol	10^n
Deci	d	10^{-1}
Centi	c	10^{-2}
Milli	m	10^{-3}
Micro	μ	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}
Femto	f	10^{-15}

Expression	Symbol	Definition
Based on volume:		
Molarity	**M**	$= \frac{\text{No. of moles of solute}}{\text{volume of solution (L)}}$
Normality	**N**	$= \frac{\text{no. of equivalents}}{\text{volume of solution (L)}}$ = nxM (n= number of OH or H)
Osmolarity	**O**	= nx M (n= number of dissociable ions)
Weight/Vol %	**wt/V%**	$= \frac{\text{Wt in gram of solute}}{\text{100ml of solution}}$
Milligram %	**mg%**	$= \frac{\text{Wt in mg of solute}}{\text{100ml of solution}}$
Vol/Vol%	**V/V%**	$= \frac{\text{volume in ml of a solute}}{\text{100ml of solution}}$
Based on weight:		
Weight/Weight%	**w/w%**	$= \frac{\text{Wt in gram of solute}}{\text{100g of solution}}$
Molality	**m**	$= \frac{\text{No. of moles of solute}}{\text{1000g of solvent}}$
Mole fraction	**MF**	$MF_2 = n_2 / (n_1 + n_2 + n_3)$
Based on saturation:		
percent saturation		$V \text{ (ml)} = \frac{100 \text{ (S2-S1)}}{1 - S2}$

Preparations of Solutions



Preparation of stock solutions for acids

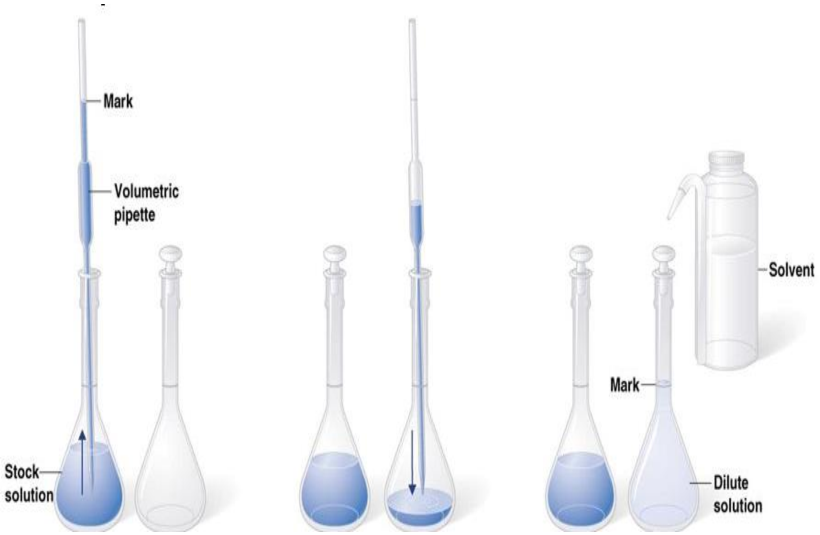
- The concentrations of many acids are given in the terms of w/w%
- In order to prepare an acid stock solution we need to know its density (ρ) or specific gravity, and calculate the needed volume by :

$$Wt(g) = \underline{\mathbf{V\ (ml)}} \times \rho \times w/w\%\ (\text{as decimal})$$

Solutions could be prepared either from

1- Solid material

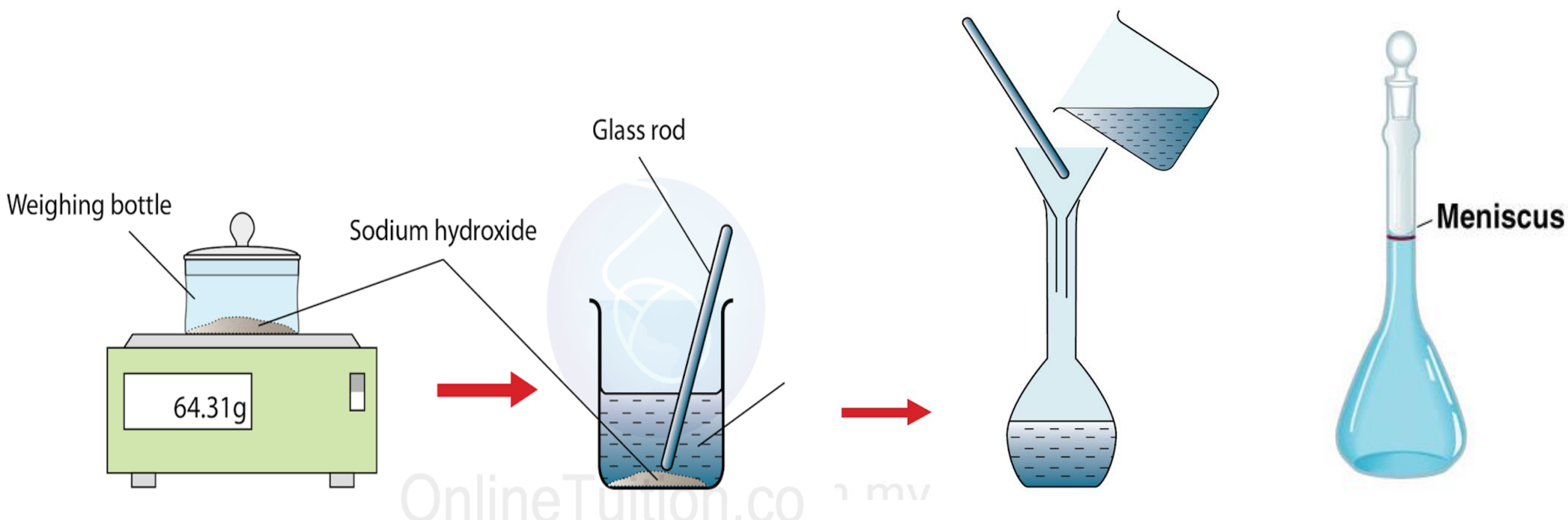
2-Liquid



Preparation of Solutions from Solid Material

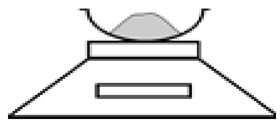
After calculating the weight required to prepare any given solution, you do the following:

1. Weigh the solute
2. Dissolve the solute.
3. Make up the solution to a known volume
4. Mix



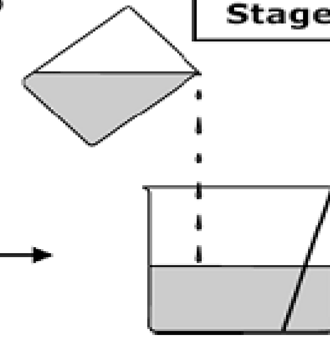
Stage 1

1. Weigh accurately the required amount of material (see section 3.2).



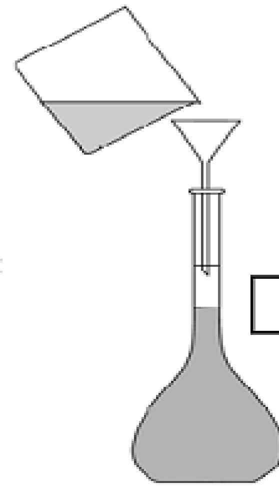
Stage 2

2. Transfer the material to a beaker and dissolve in a small amount of solvent (usually deionised water). Ensure all the solid has dissolved.

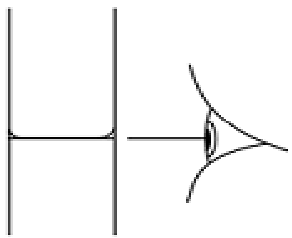


Stage 3

3. Using a clean glass funnel, transfer the solution quantitatively into a clean volumetric flask. Wash out the beaker with the solvent a number of times and transfer the washings to the flask. Hint: Pouring the liquid down a glass rod held in the spout of the beaker can help prevent liquid running down the side of the beaker.



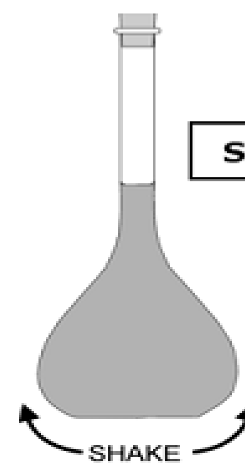
Stage 4



4. Make sure the flask and contents are at ambient temperature. Carefully add solvent to the flask. Use a pasteur pipette to slowly add solvent until the bottom of the meniscus touches the calibration mark on the neck of the volumetric flask (see section 3.1 for information on the correct use of volumetric flasks).

Stage 5

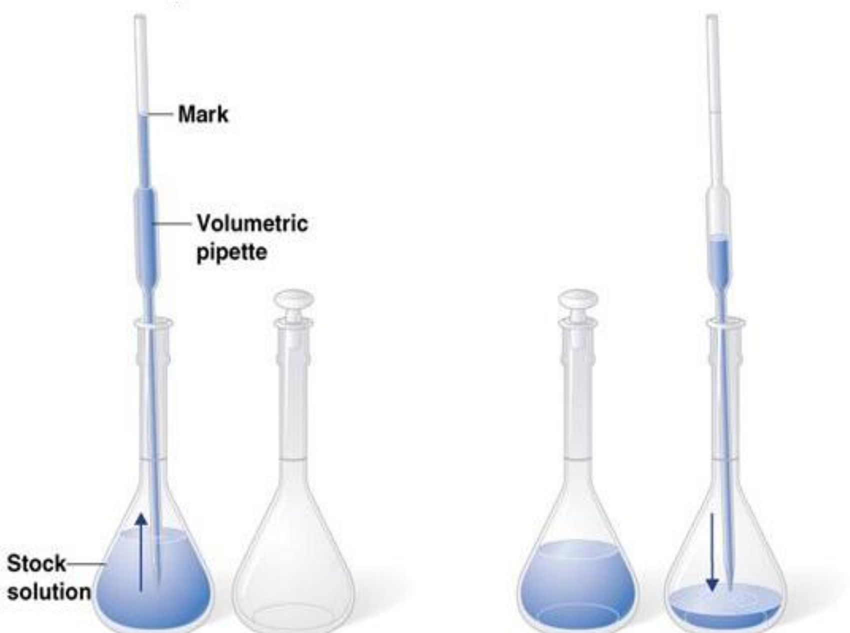
5. Stopper the volumetric flask and shake to ensure the solution is thoroughly mixed.

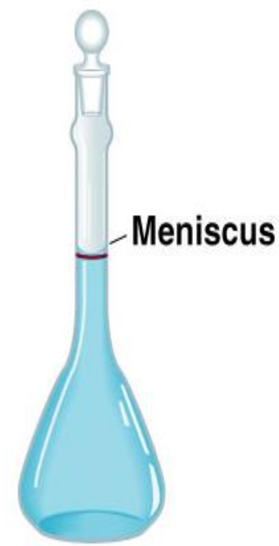


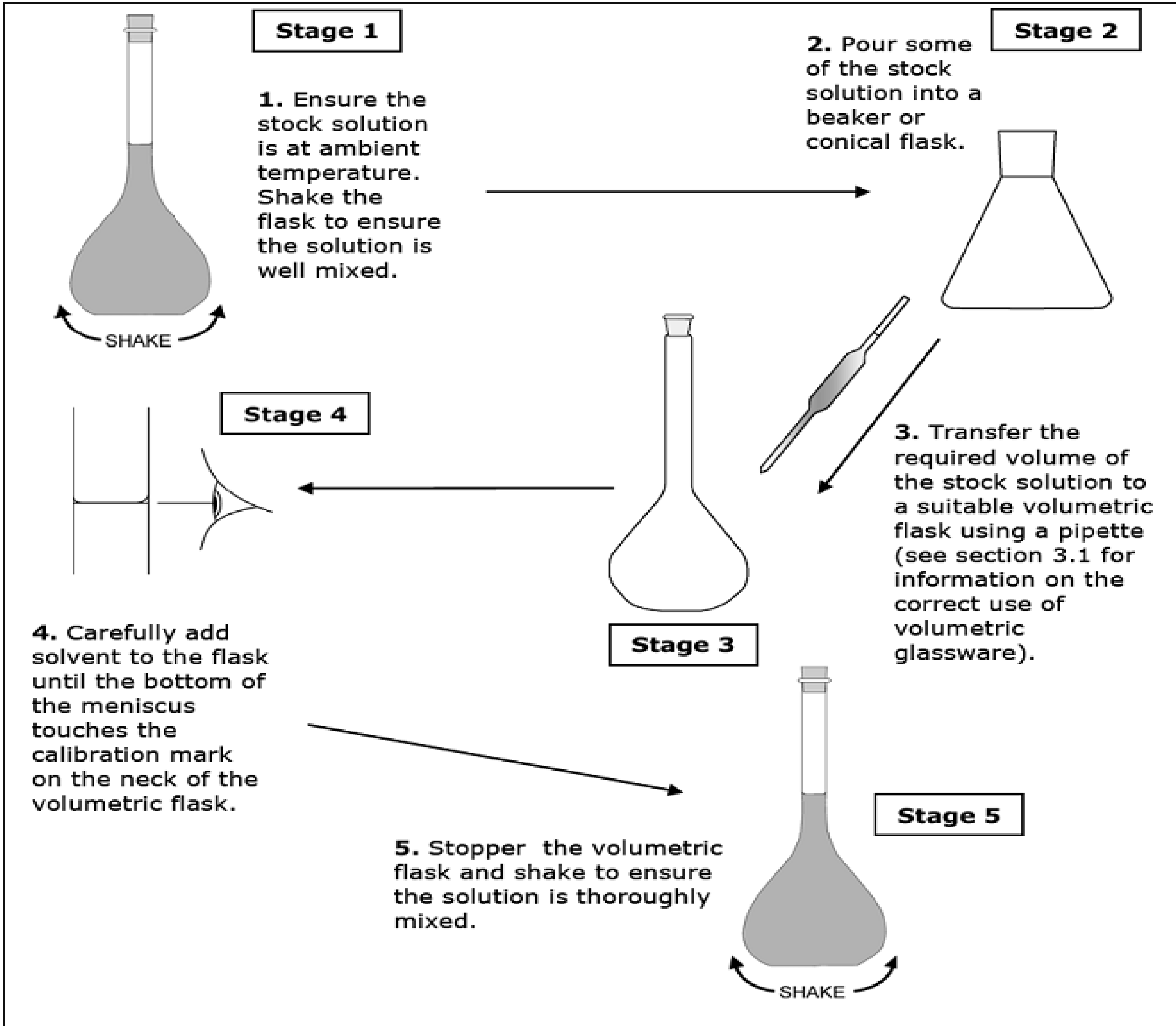
Preparation of Solutions from Liquid

- Solutions are often prepared by diluting a more concentrated stock solution.

A known volume of the stock solution is transferred to a new container → Make up the solution to a known volume → Mix







Stage 1
1. Ensure the stock solution is at ambient temperature. Shake the flask to ensure the solution is well mixed.
SHAKE
Stage 2
2. Pour some of the stock solution into a beaker or conical flask.
3. Transfer the required volume of the stock solution to a suitable volumetric flask using a pipette (see section 3.1 for information on the correct use of volumetric glassware).
Stage 3
Stage 4
4. Carefully add solvent to the flask until the bottom of the meniscus touches the calibration mark on the neck of the volumetric flask.
5. Stopper the volumetric flask and shake to ensure the solution is thoroughly mixed.
Stage 5
SHAKE

Dilutions

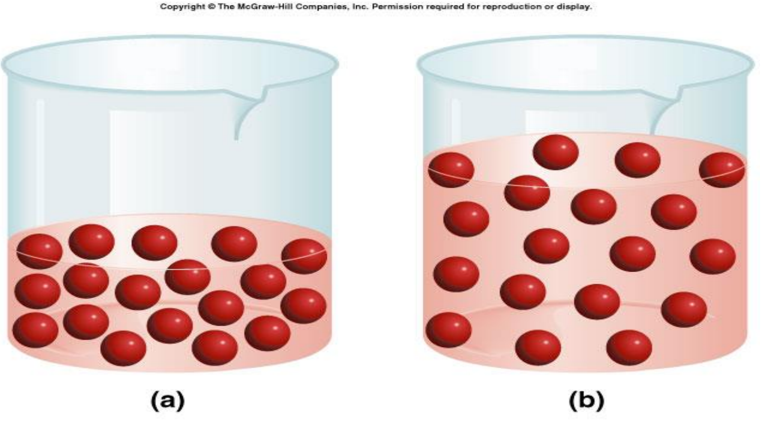
- ***Dilution*-** the procedure for preparing a less concentrated solution from a more concentrated one.

- ***Serial Dilution*-** the process of diluting a solution by removing part of it, placing this in a new flask and adding water to a known volume in the *new* flask.

Dilutions

- When a solution is diluted, solvent is added to lower its concentration.

- The amount of solute remains constant before and after the dilution:



moles BEFORE = moles AFTER

Dilutions

To calculate the concentration of diluted solutions:

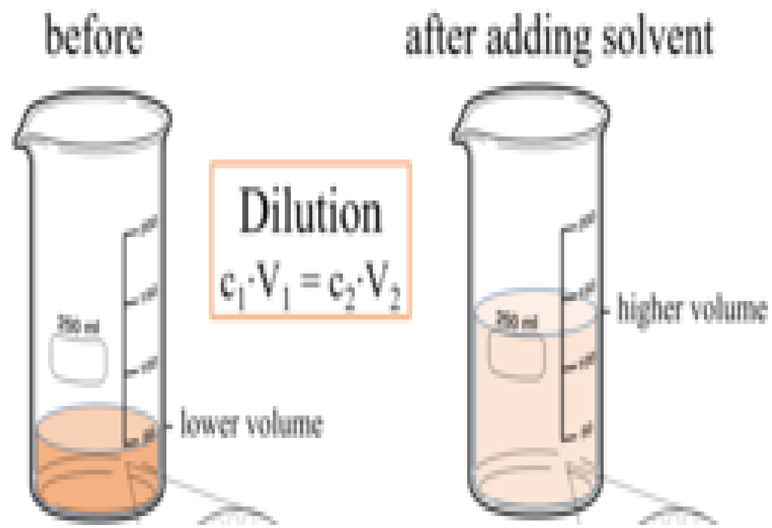
$$C_1 V_1 = C_2 V_2$$

C_1 = concentration of stock

V_1 = Volume of stock

C_2 = concentration of diluted

V_2 = Volume of diluted



Example (1)

A bottle of 0.5M standard sucrose stock solution is in the lab. How can you use the stock solution to prepare 250 mL of a 0.348M sucrose solution?

Given values:

C1= 0.5 M

V1=?

C2= 0.348M

V2= 250 ml

$C_1 X\ V_1 = C_2 X\ V_2$

$0.5\ X\ V_1 = 0.348\ X\ 250$

0.348 X 250 / 0.5 = 174 ml

i.e: 174 ml of the stock solution will be diluted with water to reach the volume of 250 ml

Example (2)

- **Describe how you would prepare 800mL of a 2.0M H_2SO_4 solution, starting with a 6.0M stock solution of H_2SO_4 .**

Given values:

C1= 6 M

V1=?

C2= 2 M

V2= 800 ml

$$C_1V_1 = C_2V_2$$
$$6.0 \times V_1 = 2.0M \times 800$$
$$6.0 \times V_1 = 1600$$
$$V_1 = 1600/6.0$$
$$V_1 = 266.6\ ml$$

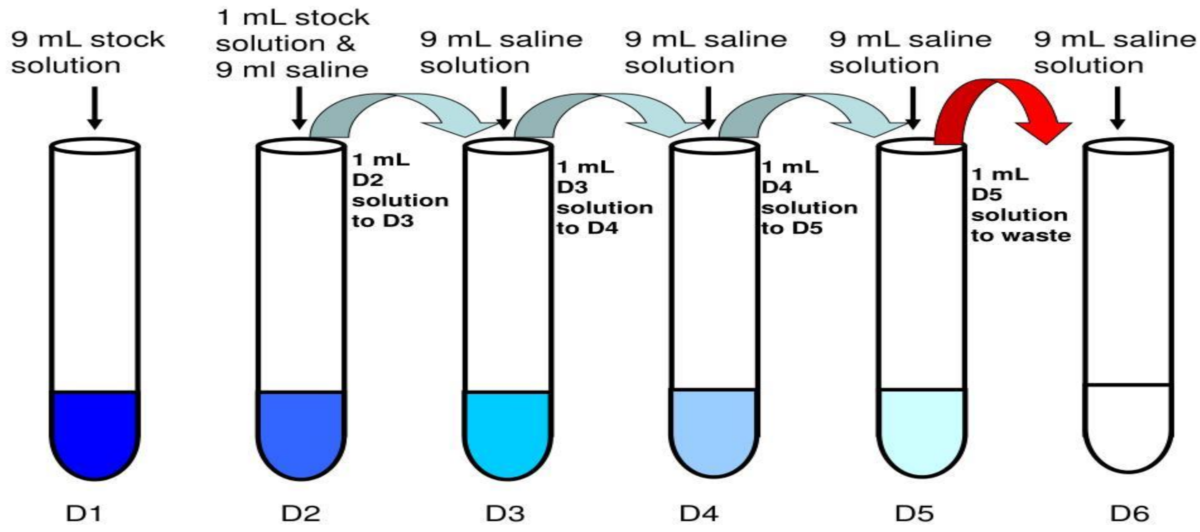
i.e:266.6 ml of the 6.0M H_2SO_4 solution should be diluted with water to give a final volume of 800mL.

Serial Dilution

- A *serial dilution* is any dilution where the concentration decreases by the same quantity in each successive step.

- Dilution starts first with stock solution and **each diluted solution produced is used to prepare the next**.

- To calculate the concentration: $C_1 V_1 = C_2 V_2$



Linear Dilution

- **Same stock solution** is used to produce samples of different concentrations.
- To calculate the concentration: $C_1 V_1 = C_2 V_2$

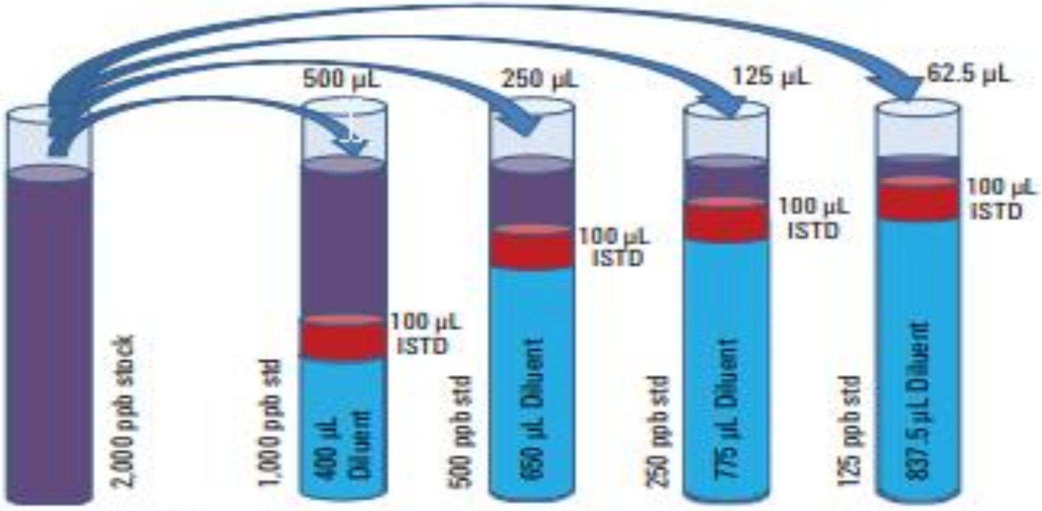


Figure 1. Linear dilutions.

Dilution Factor

- Dilution factor refers to the ratio of the volume of the initial (concentrated) solution to the volume of the final (dilute) solution

- To make a dilute solution without calculating concentrations use a dilution factor.

- Divide the final volume by the initial volume.

$$Df = Vf / Vi$$

  - Vi = initial volume (aliquot volume)
  - Vf = final volume (aliquot volume + diluent volume)
  - DF of 100 = ratio 1:100

Example (1):

- **What is the dilution factor if you add 0.1 ml aliquot of a specimen to 9.9 ml of diluent?**
  - The final volume is equal to the aliquot volume **+** the diluent volume:

    Vf = 0.1 mL + 9.9 mL = 10 mL
  - The dilution factor is equal to the final volume divided by the aliquot volume:

    Df =10 mL/0.1 mL = 1:100 dilution.

Example(2):

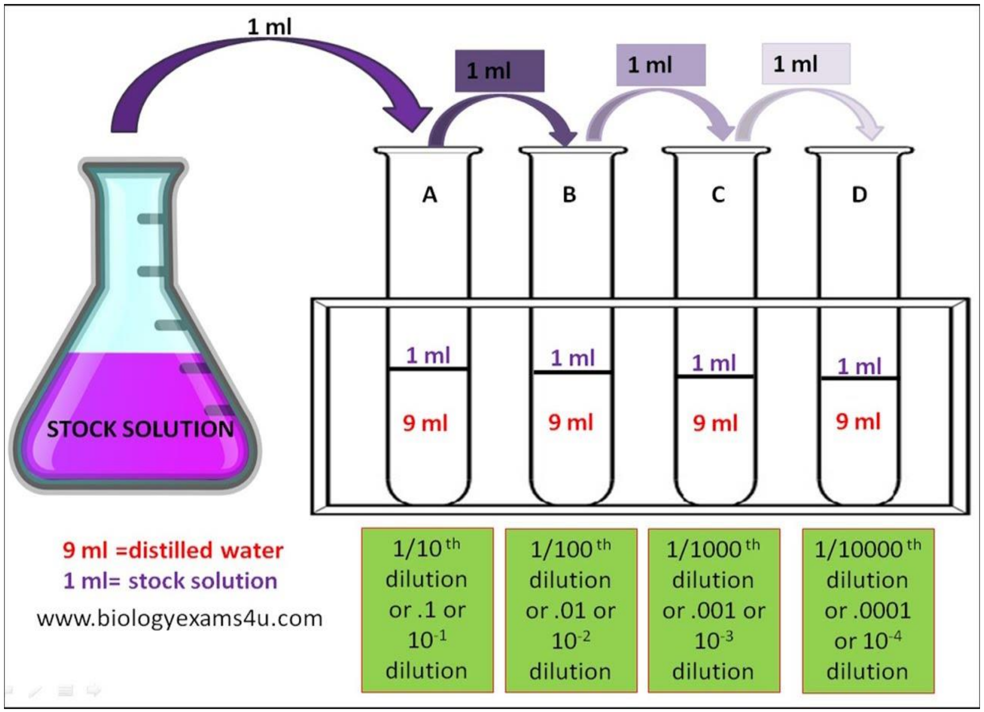
What is the Df when 0.2 ml is added to 3.8 ml diluent?

- Dilution factor = final volume/aliquot volume
- Final volume = 0.2 +3.8 = 4.0 ml
- Aliquot volume = 0.2 ml
- 4.0/0.2 = 1:20 dilution.

Example (3):

- **From the previous example if you had 4 tubes what would be the final dilution of tube 4?**
  - Since each dilution is 1:20 and we want to know the dilution of the FORTH tube so in this case it would be 1:20 multiplied FOUR times.
  - Df = 1:20 x 1:20 x 1:20 x1:20
  - Df = 1:160,000

Examples



1 ml
1 ml
1 ml
1 ml
A
B
C
D
1 ml
9 ml
1 ml
9 ml
1 ml
9 ml
1 ml
9 ml
STOCK SOLUTION
9 ml =distilled water
1 ml= stock solution
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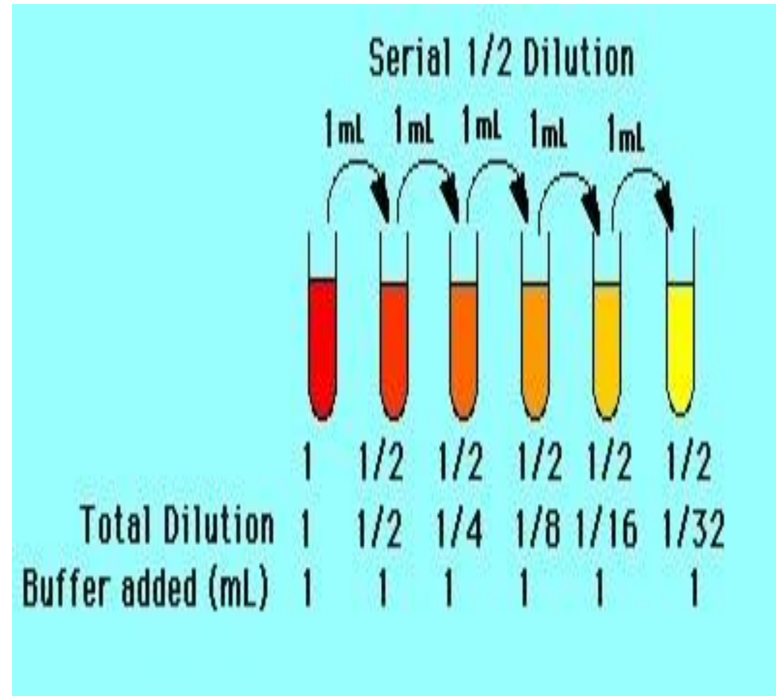
1/10 th dilution or .1 or 10-1 dilution
1/100 th dilution or .01 or 10-2 dilution
1/1000 th dilution or .001 or 10-3 dilution
1/10000 th dilution or .0001 or 10-4 dilution



Serial 1/2 Dilution
1mL 1mL 1mL 1mL 1mL
1 1/2 1/2 1/2 1/2 1/2
Total Dilution 1 1/2 1/4 1/8 1/16 1/32
Buffer added (mL) 1 1 1 1 1 1

Importance of Dilution

- **Example: A blood glucose of 800 mg/dl was obtained. According to the manufacturer the highest glucose result which can be obtained on this particular instrument is 500 mg/dl.**
  - The sample must be diluted.
  - The serum was diluted 1:10 and retested.
  - The result is 80 mg/dL.
  - *THIS IS NOT THE REPORTALBE RESULT!*
  - You must multiply by the dilution factor of **10.**
  - 10 x 80 = 800 mg/dl.