PHARMACEUTICAL CALCULATIONS

Checking solubility

- ✓ It gives information on how the product should be prepared.
- ✓ This information can be found in reference sources or can be experimentally calculated.

Definition:

- ■ Solubility is the maximum amount of solid dissolved in the liquid.
- ■ Solubility can be expressed as g, mL or part (in Turkish kısım; k).
- ■ Part can be used instead of **gram for solids** and **mL for liquids.**

Example:

- ✓ Sorbic acid dissolves in 600 parts of water, 120 parts of alcohol and 300 parts of glycerine.
- ✓ This means; 1 g sorbic acid dissolves in 600 mL of water, 120 mL of alcohol, 300 mL of glycerine.

Example

Salicylic acid……. 3 g

Resorcin …………. 3 g

Alcohol………….. 150 g

Rose water ……..150 g

Salicylic acid shows better solubility in alcohol than water.

Resorcin have good solubility in both water and alcohol.

Concentration

Concentration is the amount of material dissolved in a known volume of solution. It can be given as percentage, mole fraction or molality, normality etc.

Most common ones are:

Per cent weight in weight (w/w%)

- **Amount of substance (gram) dissolved in 100 g of a solution.**

Per cent volume in volume (v/v%)

- **Amount of substance (mL) dissolved in 100 mL of a solution.**

Per cent weight in volume (w/v%)

- **Amount of substance (gram) dissolved in 100 mL of a solution.**

Per cent volume in weight (v/w%)

- **Amount of substance (mL) dissolved in 100 g of a solution.**

Term	Abr.	Definition
Molarity (Molarite)	M, c	Mole number of the substance in 1000 mL of the solution.
Molality (Molalite)	m	Mole number of the substance dissolved in 1000 gr of the solvent.
Normality (Normalite)	N	Equivalent amount of substance dissolved in 1000 mL solution.
Mole Fraction	X, N	Ratio of the mole numbers of individual substances to the total mole number inside a solution.
Mole %		mole fraction x100

Example

Prepare 3 % w/v Boric acid aqueous solution.

- **This means that there is 3 g boric acid in 100 mL of solution.**
- **You must weight boric acid and dissolve it in the solvent (water in this case).**
- **You must complete the boric acid solution by adding the same solvent up to a volume of 100 mL.**
- **Graduated cylinder is a suitable apparatus for this procedure.**

Dilution

- **Stock solutions** are known as strong solutions from which the weaker ones may be prepared.
- When they are correctly made, pharmacist can accurately obtain the small quantities of the active substances.
- They can be prepared as w/v % or v/v% and their concentration is expressed as ratio or percentage.

For example

- Aluminium Subacetate Topical Solution (USP 27)
- Hydrogen Peroxide Solution

are prepared as stock solution and must be/can be diluted before use.

Dilution

By using the formula below we can prepare a desired dilution of a stock formulation.

C1 . V1 = C2 . V2

C1, C2 are initial and final concentrations, respectively.
V1, V2 are initial and final volumes, respectively.

Example:

If we dilute a stock solution of 15v/v%, 500 mL to a 1500 mL what will be the final concentration for diluted solution?

Our initial concentration is 15% → 100 mL 15 mL
We have 500 mL → 500 mL x= **75 mL**

If the final volume of 1500 mL consists a 75 mL stock solution;
1500 mL 75 mL
100 mL **x = 5 v/v %**

C1 . V1 = C2 . V2

15 . 500 = C2 . 1500 ⇒ C2 = %5 (v/v)

Dilution

One of the most important usage for dilutions are alcohol dilutions.

Diluted alcohols must be calculated by using alcohol grade (°) and volume and must be prepared by completing to a final volume or mass.

Example

How can you prepare a 500 mL of 50%(v/v) alcohol from a stock solution of 85° alcohol?

Your stock is 85% v/v and you need a 50% v/v alcohol;

C1 . V1 = C2 . V2

85 x V1 = 50 x 500 V2= 294,10 mL water

This means, if you measure a 294,10 mL of 85% alcohol into a graduated cylinder and complete to a final volume of 500 mL, you will have 50% v/v alcohol.

Note that; alcohol grades and final amounts must be given in same units !

$$(\%v/v)_1 \text{ x } mL_1 = (\%v/v)_2 \text{ x } mL_2$$

or

$$(\%w/w)_1 \text{ x } mg_1 = (\%w/w)_2 \text{ x } mg_2$$

Trituration

These are dilutions of potent active substances which are prepared by mixing finely powdered actives with finely powdered lactose in a definite proportion by weight.

Generally trituration is given as:

Dilute one part by weight of the active substance with nine parts by weight of lactose.

- → 10 %
- → 1 :10
- → 1 + 9

This dilution type offers to the pharmacist to obtain small quantities of potent active substances conveniently and accurately.

Rx   100 capsules

Colchicine……. 8.33×10^{-5} g 8.33×10^{-3} g (0.0083 g)

Aspirin ……….. 0.325 g   32.5 g

M.f.t. Caps no: 100

- For preparing 1 capsule you must weigh $8.33 .10^{-5}$ g colchicine and you need $8.33 .10^{-3}$ g colchicine for 100 capsules.
- Both amounts are very small for your balances.
- Thus you can prepare;

1 g colchicine + 9 g lactose = 10 g (%10 trituration)

100g   10 g

X   0.0083 g

X = 0.083 g = 83 mg trituration contains the amount of colchicine that you need.

32.5 g aspirin and 83 mg trituration weighed and mixed for 100 capsules

Alligation

This is a method for determining the parts of 2 or more components of known concentration to be mixed when final desired concentration is known. Alligation has two types;

- **Alligation medial**

This is a method by which the weighted average percentage strength of a mixture of 2 or more substances whose quantities and concentrations are known may be quickly calculated.

Known parameters are → initial percentage and amounts

Unknown parameter is → final concentration

- **Alligation alternate**

This is a method by which we may calculate the parts of 2 or more components of a given strength when they are mixed to prepare a mixture of desired strength.

Known parameters are → initial and final percentage

Unknown parameter is → initial amounts to be used

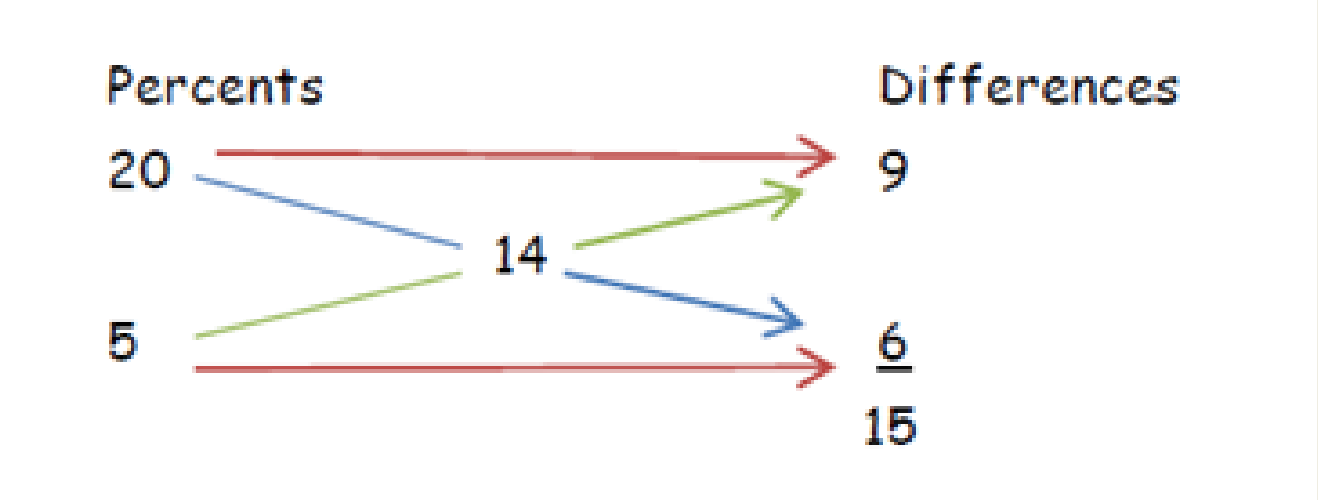
Alligation alternate

- Alligation is a rapid method of calculation.
- The term comes from the lines drawn during calculation with alligation alternate method.
- Main rule is,
- ✓ The substance with higher value (%, concentration..) than required is the one with lower amount.
- ✓ The gain in amount/value of one substance balances the loss in amount/value of another substance.

Example

How much 5% solution and 20% solution must be combined to make 120 mL of 14% solution ?

- ➢ Higher concentration (20%) must be lower in volume.
- ➢ You must find the differences between the known and desired percentages.



20-14 = 6 parts
14-5 = 9 parts
9+ 6 parts = 15 parts (corresponds to total volume of 120 mL)

15 part 120 mL
1 part x = 8 mL

8 ml x 9 part = 72 mL (20 %)
8 mL x 6 part = 48 mL (5 %)

If we mix 72 mL of 20% and 48 mL of 5% solutions we can make a 120 mL of 14% final solution.

Alligation medial

In this method, in order to mix different strengths, a series of quantities are multiplied by their respective concentrations which equals to the product obtained by multiplying a concentration by the sum of the quantities.

Example

What is the percent of a final solution of a mixture made by mixing 72 mL of 20% solution and 48 mL of 5% solution?

72 mL x (20/100)= 72 x 0.2 = 14.4
48 mL x (5/100) = 48 x 0.05 = 2.4

Total volume is: 72 + 48 = 120 mL
Total part calculated is 14.4+ 2.4 = 16.8 (16.8 %)

120 ml 16.8 %
100 **x= 14 %**

Density

density= Mass in grams/ Volume in mL

$d = g/mL\ (g/cm^3)$

In pharmacy practice it is important to convert grams to mL for the solutions given in w/w % concentration.

Several terms are used to express the mass of equal volumes of different substances.

- Absolute density
- Apparent density
- Relative density
- Specific gravity

Absolute density is the ratio of the mass to the volume of an object. It is determined in a vacuum at a specified temperature.

Apparent density differs from absolute density only in that the mass is determined in air.

Relative density is the ratio of the density of a substance to the density of a given reference material.

Specific Gravity

- is the ratio of mass of a substance to the mass of an equal volume of another substance taken as the standart.
- For gases hydrogen or air, for liquids and solids water can be used as the standart.
- The specific gravity of a substance and its density is numerically equal but specific gravity is a ratio which decimally expressed and has no dimensions.

$$\text{Specific gravity} = \frac{\text{mass of substance}}{\text{mass of equal volume of water}}$$

Density= Mass/volume

- Specific gravity can be determined by using a specific gravity bottle (pycnometer) or can be determined from Archimedes law (using areometer).

Pycnometer

- **Pycnometer is an apparatus used for calculating specific gravity.**
- **First of all, the weight of empty container is determined. After that, the container is filled with water and weighed. Finally, the container is filled with the other liquid and weighed. By substracting the weight of empty container from the weights of filled containers, the weights of two liquids at equal volumes can be calculated.**

Specific Volume

- **Specific volume is the ratio of volume of a substance to the volume of an equal weight of another substance taken as standard, both having the same temperature.**

- **Temperature is generally 20^{o}C and standard is water.**

Areometer (Hydrometer)

- **Areometer is the device used to determine specific gravity of a liquid directly.**
- **It consists of a thin glass tube closed at both ends, with a bulb which contains mercury to provide the instrument to float upright in a liquid.**
- **Areometer has two types according to the density of liquids, which can be heavier or lighter than water.**

  - A commercial type is Baumé densitometer which has constant weight and scaled according to water consisting salt.
  - Following equations can be used for test liquids denser or lighter than water.

    B°: 145-145/D (Denser than water)
    B°: 140/D-130 (Lighter than water)

  - Areometer is useful to convert w/w amounts to v/v in heavy liquids such as syrups.