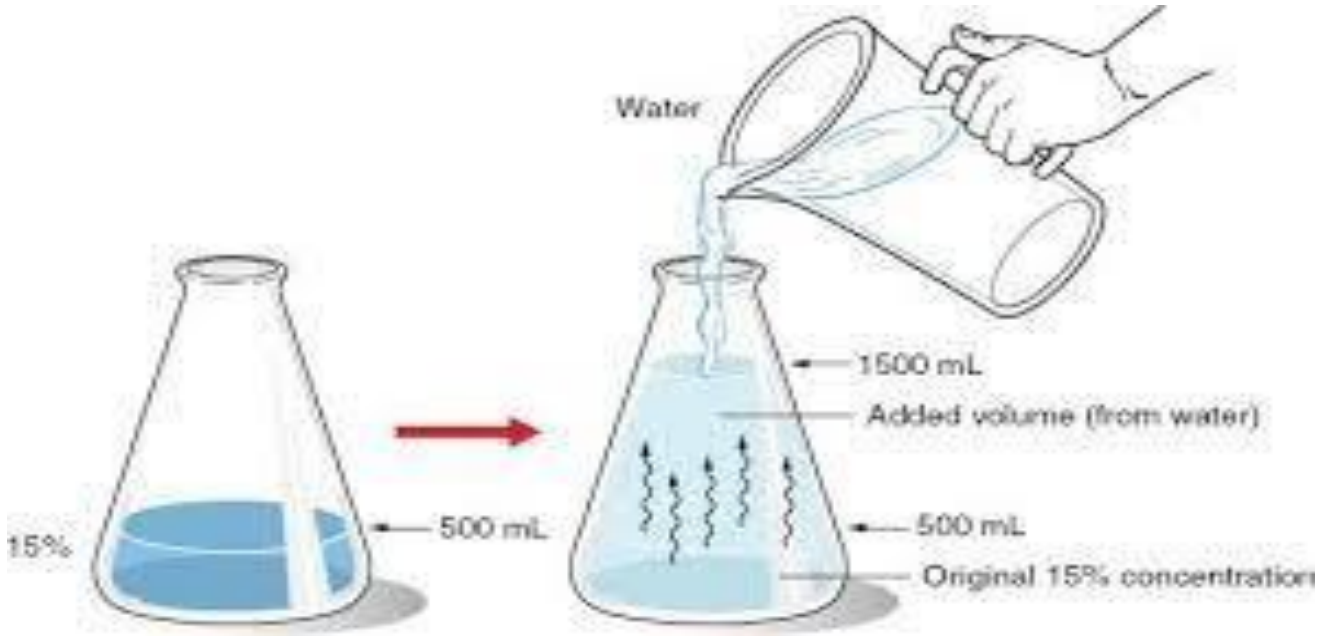
AL-Mustaqbal university
College of Pharmacy

Pharmaceutical calculation

Dilution and concentration of pharmaceutical preparation lec1



The strength of a pharmaceutical preparation may be increased or decreased by changing the proportion of active ingredient to the whole.

- **A preparation may be strengthened or made more concentrated by the addition of active ingredient, by admixture with a like preparation of greater strength, or through the evaporation of its vehicle, if liquid.**

- **The strength of a preparation may be decreased or diluted by the addition of diluent or by admixture with a like preparation of lesser strength.**

The dilution of a liquid dosage form, as a solution or suspension, may be desired to provide a product strength more suitable for use by a particular patient (e.g., pediatric, elderly, those in disease states)

The diluent is selected based on its compatibility with the vehicle of the original product; that is, aqueous, alcoholic, hydroalcoholic, or other .

The dilution of a solid dosage form (as a powder or the contents of a capsule) or a semisolid dosage form (as an ointment or cream) also may be performed to alter the dose or strength of a product .

The concentration of a liquid preparation, as through the evaporation of a portion of its solvent or vehicle, **rarely is performed nowadays.**

However, the fortification of a liquid, solid, or semisolid dosage form, by the addition of a calculated quantity of additional therapeutic agent, remains a viable practice in pharmacy compounding

If a mixture of a given percentage or ratio strength is diluted to twice its original quantity, its active ingredient will be contained in twice as many parts of the whole, and its strength therefore will be reduced by one half .

By contrast, if a mixture is concentrated by evaporation to one-half its original quantity, the active ingredient (assuming that none was lost by evaporation) will be contained in one half as many parts of the whole, and the strength will be doubled

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so, if 50 mL of a solution containing **10** g of active ingredient with a strength of **20**% or 1:5 w/v are diluted to 100 mL, the original volume is doubled, but the original strength is now reduced by one half to 10% or 1:10 w/v. If, by evaporation of the solvent, the volume of the solution is reduced to 25 mL or one half the original quantity, the **10** g of the active ingredient will indicate a strength of **40**% or **1:2.5** w/v.

The percentage or ratio strength (concentration) of a component in a pharmaceutical preparation is based on its quantity relative to the total quantity of the preparation .

If the quantity of the component remains constant, any change in the total quantity of the preparation, through dilution or concentration, changes the concentration of the component in the preparation **inversely**. An equation useful in these calculations is

1^{st} quantity x 1^{st} concentration =(2nd quantity)x(2nd concentration)

or **Q1 x C1 = Q2 x C2**

Example Calculations of the Dilution and Concentration of Liquids

If 500 mL of a 15% v/v solution are diluted to 1500 mL, what will be the percentage strength (v/v?(

$$Q1\ (\text{quantity}) \times C1\ (\text{concentration}) = Q2\ (\text{quantity}) \times C2\ (\text{concentration})$$

$$500\ (\text{mL}) \times 15\ (\%) = 1500\ (\text{mL}) \times x\ (\%)$$

$$x = 5\%, \textit{answer.}$$

If 50 mL of a 1:20 w/v solution are diluted to 1000 mL, what is the ratio strength (w/v?(

Note: A student may find it simpler in solving certain problems to convert a given ratio strength to its equivalent percentage strength

$$\text{Q1 (quantity)} \times \text{C1 (concentration)} = \text{Q2 (quantity)} \times \text{C2 (concentration)}$$
$$50\ (\text{mL}) \times 5\ (\%) = 1000\ (\text{mL}) \times (\%)$$
$$x = 0.25\% = 1{:}400, \textit{answer.}$$

Or,

50 mL of a 1:20 solution contains 2.5 g of solute

$$\frac{2.5\ (\text{g})}{1\ (\text{g})} = \frac{1000\ (\text{mL})}{x\ (\text{mL})}$$
$$x = 400\ \text{mL}$$
$$\text{Ratio strength} = 1{:}400, \textit{answer.}$$

How many milliliters of a 1:5000 *w/v solution of the preservative auralkonium chloride can be made from 125 mL of a 0.2% solution?*

1/5000 x 100 % = 0.02 %

V1 C1 = V2 C2

125 (mL) x 0.2 (%) = X (mL) x 0.02 (%)

X= 1250 mL,

Strengthening of a Pharmaceutical Product

The addition of active ingredient or by the admixture with a calculated quantity of a like-product of greater concentration

example calculations of product strengthening

- **If a cough syrup contains in each teaspoonful, 1 mg of chlorpheniramine maleate and if a pharmacist desired to double the strength, how many milligrams of that ingredient would need to be added to a 60-mL container of the syrup. Assume no increase in volume**

$$\frac{1\ \text{mg}}{5\ \text{mL}} \times 60\ \text{mL} = 12\ \text{mg chlorpheniramine maleate in original syrup}$$

To double the strength, 12 mg of additional chlorpheniramine maleate would be required, *answer*.

Stock Solutions

Stock solutions are concentrated solutions of active (e.g., drug) or inactive (e.g., colorant) substances and are used by pharmacists as a convenience to prepare solutions of lesser concentration

Example Calculations of Stock Solutions

How many milliliters of a 1:400 w/v stock solution should be used to make 4 liters of a 1:2000 w/v solution?

4 liters = 4000 ml

1/400 x 100 % = 0.25 %

1/2000 x 100 % = 0.05 %

V1 C1 = V2 C2

4000 ml * 0.05 % = X ml * 0.25 %

X= 800 ml

How many milliliters of a 1% stock solution of a certified red dye should be used in preparing 4000 mL of a mouthwash that is to contain 1:20,000 w/v of the certified red dye as a coloring agent?1

1:20000 x 100% = 0.005%

V1	*C1*	=	*V2*	*C2*
1% x	X(ml)	=	4000(ml) x	0.005%

X= 20 ml

How many milliliters of a 1:50 stock solution of phenylephrine hydrochloride should be used in compounding the following prescription?

℞ Phenylephrine HCl 0.25%
Rose Water ad 30 mL.
Sig. For the nose.

$$1:50 = 2\%$$

$$\frac{2\ (\%)}{0.25\ (\%)} = \frac{30\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 3.75\ \text{mL}, \textit{answer}.$$

How many milliliters of water should be added to a pint of a 5% w/v solution to make a 2% w/v solution?

1 pint = 473ml

C1 V1 = C2 V2

473 ml x 5% = (X)ml x 2%

X= 1182.5 ml

and 1182.5 ml – 473 ml = 709.5 ml

How many milliliters of water should be added to 375 mL of a solution containing 0.5 g of benzalkonium chloride to make a 1:5000 solution?

$1 / 5000 \times 100\% = 0.02\ \%$

$0.5 / 375 \times 100\% = 0.133\ \%$

$C1\ \ V1 = \ \ C2\ \ V2$

$375ml \times 0.133\% = V2ml \times 0.02\%$

$V2 = 2500$

$2500ml - 375ml = 2125\ ml$

If 15 mL of a 0.06% ATROVENT (ipratropium bromide) nasal spray were diluted with 6 mL of normal saline solution, what would be the final drug concentration?

V2 = 15 ml + 6ml = 21 ml

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$$15\ (\text{mL}) \times 0.06\ (\%) = 21\ (\text{mL}) \times x\ (\%)$$

$$x = 0.043\ \%,\ \textit{answer.}$$

Dilution of alcohol

When water and alcohol are mixed, there is a physical contraction such that the **resultant volume** is **less** than the **total of the individual** volumes of the two liquids .

Thus, to prepare a *volume-in volume* strength of an alcohol dilution, the alcohol ‘‘solute’’ may be determined and water used to ‘ q.s.’’ to the appropriate volume .

Because the contraction of the liquids does not affect the *weights* of the components, the *weight of water* (and from this, the *volume*) needed to dilute alcohol to a desired *weight-in-weight* strength may be calculated

How much water should be added to 4000 g of 90% w/w alcohol to make 40% w/w alcohol?

$$V1\ C1 = V2\ C2$$

$$X(g) \times 40\% = 4000g \times 90\%$$

$$X = 9000\ g$$

$$9000g - 4000g = 5000\ g = 5000\ ml$$

How many milliliters of 95% v/v alcohol and how much water should be used in compounding the following prescription?

℞	Xcaine	1 g
	Alcohol 70%	30 mL
	Sig. Ear drops.	

$$\frac{95\ (\%)}{70\ (\%)} = \frac{30\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 22.1\ \text{mL}$$

Therefore, use 22.1 mL of 95% v/v alcohol and enough water to make 30 mL, *answer.*

Dilution of acids

The strength of an official undiluted (*concentrated*) acid is expressed as percentage weight-in weight. For example, Hydrochloric Acid, NF, contains not less than 36.5% and not more than 38.0%, by weight, of HCl .

However, the strength of an official *diluted* acid is expressed as percentage weight-in-volume. For example, Diluted Hydrochloric Acid, NF, contains, in each 100 mL, not less than 9.5 g and not more than 10.5 g of HCl .

It is necessary, therefore, to consider the specific gravity of concentrated acids in calculating the volume to be used in preparing a desired quantity of a diluted acid

How many milliliters of 85% w/w phosphoric acid having a specific gravity of 1.71 should be used in preparing 1 gallon of 1⁄4% w/v phosphoric acid solution to be used for bladder irrigation?

¼ x 100 % = 0.25%

1 gallon = 3785 ml

V1 C1 = V2 C2

X ml x 85% = 3785 ml x 0.25%

X= 11.13 ml

11.3 ml / 1.71 = 6.5 ml

Dilution and Fortification of Solids and Semisolids

The dilution of solids in pharmacy occurs when there is need to achieve a lower concentration of an active component in a more concentrated preparation (e.g., a powdered vegetable drug)

Example Calculations of Solid and Semisolid Dilutions

If 30 g of a 1% hydrocortisone ointment were diluted with 12 g of Vaseline, what would be the concentration of hydrocortisone in the mixture?

$$V2 = 30\ g + 12\ g = 42\ g$$

30 (g) 1 (%) = 42 (g) x (%)

X= 0.71% (w/w), *answer*.

Trituration

There also is a type of diluted pharmaceutical preparation, termed a **Trituration** (are dilutions of potent medicinal substances. They were at one time official and were prepared by diluting one part by weight of the drug with nine parts of finely powdered lactose. They are, therefore, 10% or 1:10 w/w mixtures).

Reducing or enhancing the strengths of creams and ointments is a usual part of a compounding pharmacist's practice to meet the special needs of patients.

The dilution of semisolids is a usual part of a compounding pharmacist's practice in reducing the strengths of creams and ointments to meet the special needs of patients

How many milliliters of an injection prepared by dissolving 100 mg of a 1:10 trituration of mechlorethamine hydrochloride in sufficient water for injection to prepare 10 mL of injection is required to obtain 5 mg of drug?

100 mg of trituration = 10 mg of drug

10 mg of drug in 10 mL of injection

V1 C1 = V2 C2

10(ml) x 5 (mg) = X(ml) x 10 (mg)

x = 5 mL, *answer.*

Alligation

Alligation is an arithmetical method of solving problems that involves the mixing of solutions or mixtures of solids possessing different percentage strengths.

Alligation Medial. Alligation medial is a method by which the ‘‘weighted average’’ percentage strength of a mixture of two or more substances of known quantity and concentration may be easily calculated.

C1 * V1 = X1
C2 * V2 = X2
C2 * V3 = X3

Alligation Medial = Total X / Total V x100%

What is the percentage strength (v/v) of alcohol in a mixture of 3000 mL of 40% v/v alcohol, 1000 mL of 60% v/v alcohol, and 1000 mL of 70% v/v alcohol? Assume no contraction of volume after mixing.

0.40 x 3000 mL = 1200 mL

0.60 x 1000 mL = 600 mL

0.70 x 1000 mL = 700 mL

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Totals: 5000 mL 2500 mL

2500 (mL) / 5000 (mL) = 0.50 x 100% = 50%, *answer.*

In some problems, the addition of a solvent or vehicle must be considered. It is generally best to consider the diluent as of zero percentage strength, as in the following problem.

What is the percentage strength of alcohol in a mixture of 500 mL of a solution containing 40% v/v alcohol, 400 mL of a second solution containing 21% v/v alcohol, and a sufficient quantity of a nonalcoholic third solution to make a total of 1000 mL?

0.40 x 500 mL = 200 mL

0.21 x 400 mL = 84 mL

0 x 100 mL = 0 mL

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Totals: 1000 mL = 284 mL

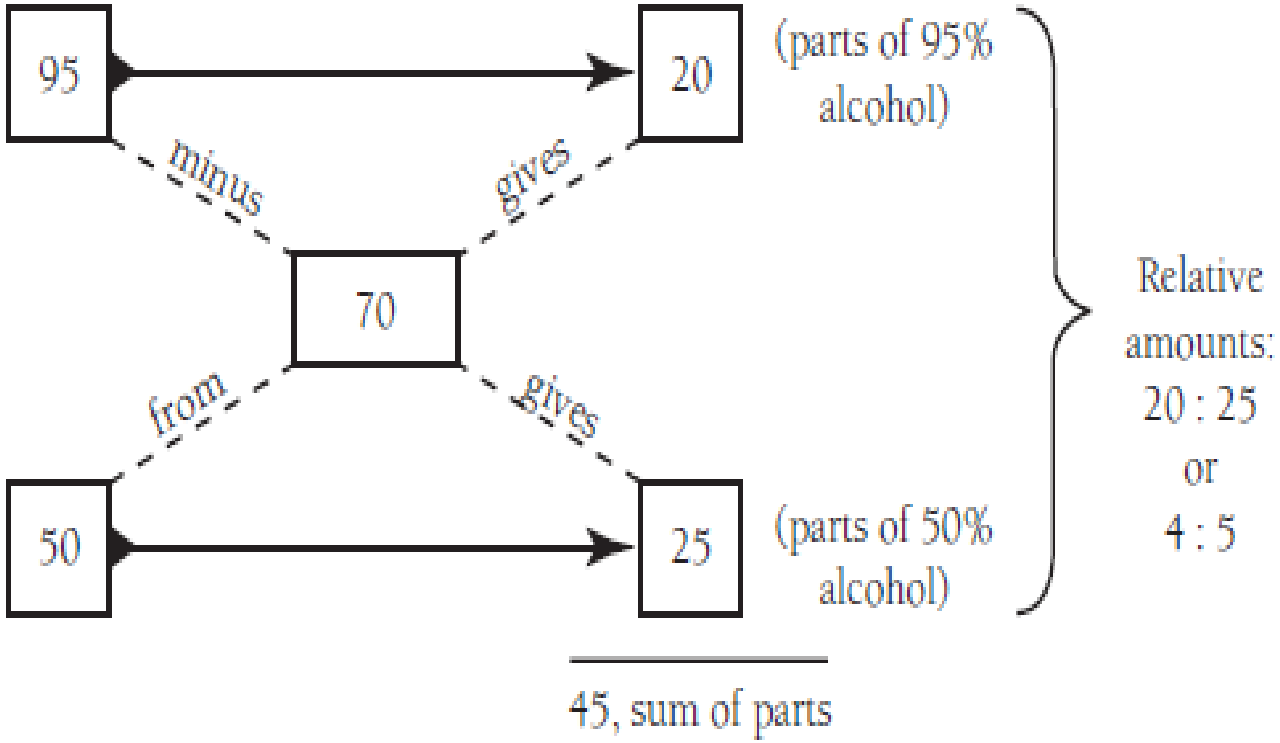
284 (mL) / 1000 (mL) = 0.284 x 100 % = 28.4%, *answer.*

Alligation alternate is a method by which we may calculate the number of parts of two or more components of a given strength when they are to be mixed to prepare a mixture of desired strength. A final proportion permits us to translate relative parts to any specific denomination.

Example Calculations Using Alligation Alternate

In what proportion should alcohols of 95% and 50% strengths be mixed to make 70% alcohol?

Note that the difference between the *strength of the stronger component* (95%) and the *desired strength* (70%) indicates the *number of parts of the weaker* to be used (25 parts), and the difference between the *desired strength* (70%) and the *strength of the weaker component* (50%) indicates the *number of parts of the stronger* to be used (20 parts).



How many milliliters of 50% w/v dextrose solution and how many milliliters of 5% w/v dextrose solution are required to prepare 4500 mL of a 10% w/v solution?

50%	10%	5 parts of 50% solution
5%		40 parts of 5% solution

Relative amounts 5:40, or 1:8, with a total of 9 parts

$$\frac{9\ (\text{parts})}{1\ (\text{part})} = \frac{4500\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 500\ \text{mL of 50\% solution, } \textit{and}$$

$$\frac{9\ (\text{parts})}{8\ (\text{parts})} = \frac{4500\ (\text{mL})}{y\ (\text{mL})}$$

$$y = 4000\ \text{mL of 5\% solution, } \textit{answers.}$$


THANK
YOU