CALCULATIONS
by **RXpharmaLAB.com**

ALLIGATION

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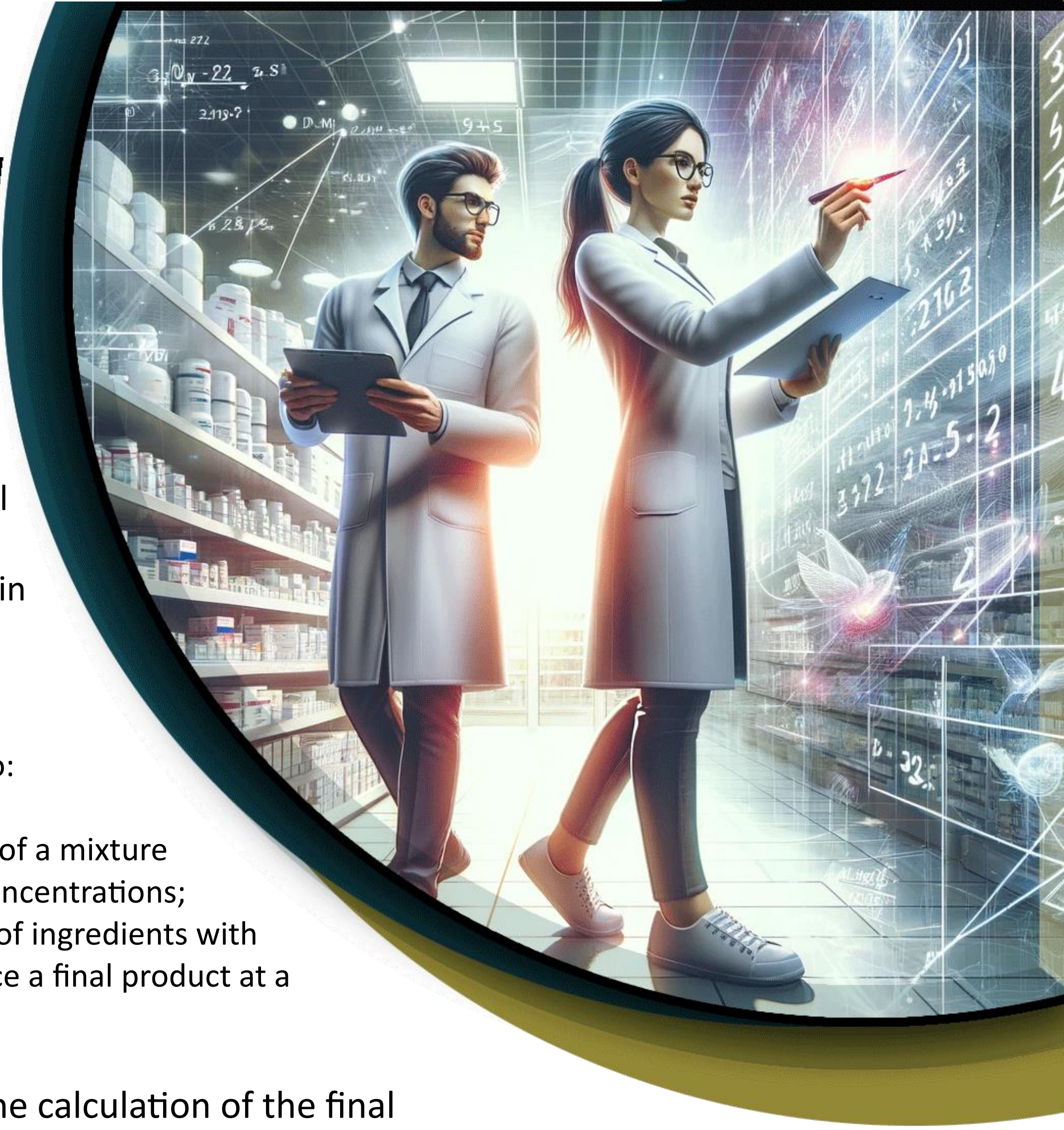

Alligation is a calculation method used in pharmacy for solving problems in mixing and preparing various pharmaceutical forms, such as solutions, creams, gels, and ointments, which contain the same substance at different concentrations.

This document provides the tools to:

- calculate the final concentration of a mixture involving products at different concentrations;
- determine the required amount of ingredients with distinct concentrations to produce a final product at a specific concentration.

Alligation MEDIAL allows for the calculation of the final concentration of a mixture of products with different concentrations.
Alligation ALTERNATE allows you to determine the quantities of ingredients necessary to obtain a final product at a specific concentration.

Let's begin with **alligation**, which allows us to determine the final concentration resulting from mixing products of different concentrations.

Consider a scenario where we need to mix the contents of three alcohol bottles. For example, the first bottle contains **500 mL of alcohol at 40%** (v/v), the second has **200 mL at 60%** (v/v), and the third **50 mL at 70%** (v/v).

We start by calculating the final volume of the mixture. Simply adding the volumes of the three bottles gives us a total of 750 mL.

500 mL + 200 mL + 50 mL = **750 mL** (1)

The next step is to determine the final concentration achieved after mixing these 750 mL.

For information related to percentages (w/w, v/v, w/v),
feel free to consult the document titled **CALCULATIONS – PERCENTAGES**,
also available at RXpharmaLAB.com.

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The volume of each component is multiplied by its respective concentration to calculate its *part* in the final mixture. These *parts* are added to find the total number of *parts*, which shows the proportional contribution of each component to the composition of the final product.

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200 mL à 60%	➡	200 x 60 =	**12 000 p** +
500 mL à 40%		500 x 40 =	**20 000 p** +
50 mL à 70%		50 x 70 =	**3 500 p**
			35 500 p

Then, to obtain the final concentration, we divide the total *parts* by the final volume:

35 500 p / 750 mL = **47,33333** **3**

This calculation indicates that the final concentration of the mixture is approximately **47.3%** (v/v).

Medial Alligation
in summary

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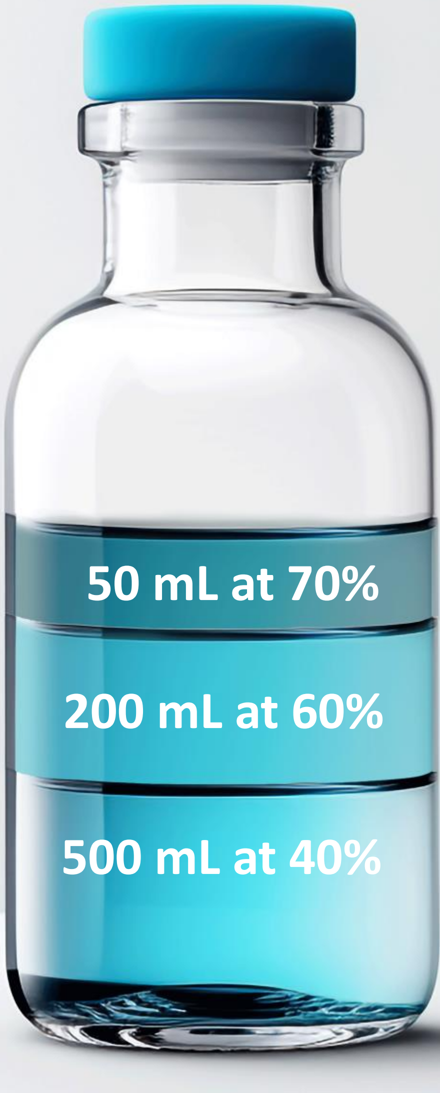
	200 mL x 60 %	=	**12 000 p** +
+	**500 mL** x 40 %	=	**20 000 p** +
+	**50 mL** x 70 %	=	**3 500 p**
1	**750 mL**	÷	**35 500 p** **3**

≈ 47,3%



Each component influences the final concentration of the mixture based on its **volume** and **concentration**.

6,67 % *of the total volume*

3500 parts *of the final concentration*

26,67 % *of the total volume*

12 000 parts *of the final concentration*

66,67 % *of the total volume*

20 000 parts *of the final concentration*

Although the 50 mL at 70% represents only a small portion of the total volume, it plays a significant role in determining the final concentration. Its impact is more pronounced than that of an equal amount of a less concentrated substance. This is because the 50 mL at 70% accounts for 3,500 *parts* of the final concentration, while, for example, 50 mL at 40% would have represented only 2,000 *parts*. Indeed, even though the volume is the same, the higher concentration implies a more substantial contribution to the final concentration. Thus, in the calculation, **the concentration of each component is as important as its volume**. In summary, the 50 mL at 70% has a greater influence on the final concentration than 50 mL of a substance at a lower concentration, as it contributes a larger amount of active substance to the mixture, thereby increasing the final concentration more significantly than the same amount of a less concentrated substance.

Let's now address **alligation alternate**, a particularly useful calculation in pharmacy when faced with the task of creating a product at a specific concentration that is not directly available. This method allows for the effective combination of ingredients at different concentrations to achieve the desired concentration in the final product.

Imagine we have two jars of cream with the same active ingredient but at different concentrations: one at **20%** (w/w) and the other at **5%** (w/w).
Our goal is to prepare **250 g of cream at 12%** (w/w).

To solve this problem, we apply a cross-multiplication calculation. We start by noting the available concentrations on the left, regardless of their position. Then, we place the desired concentration in the center and connect the figures to form an 'X'. We proceed with subtractions following the lines of the 'X'. The differences obtained represent the 'shares' of each concentration in the final mixture.

20 % - → 12 % → ***7 parts***

5 % - → 12 % → ***8 parts***

The difference between 20% and 12% = **8 parts**
The difference between 5% and 12% = ***7 parts**
The absolute value* must be used.

* Note that the absolute value must be used in this calculation. The absolute value of a number represents its value regardless of its sign, ensuring it is always positive. This is important in alternate alligation to accurately reflect the physical quantities of the ingredients to be used.

The sum of these *parts* = the total number of *parts* that make up the preparation; **15 *parts* = 250 g of cream at 12 %** (w/w).

20 % ⇢ ***7 parts***

12 % +

5 % ⇢ ***8 parts***

15 parts

The numbers of *parts* thus found must be associated with the concentration of the ingredient located on the opposite end of the same line:

- the **20%** (w/w) cream, will occupy **7** out of 15 shares,
- the **5%** (w/w) cream, will occupy **8** out of 15 shares.

Let's now use the rule of three to calculate the necessary quantities of each cream:

250 g of 12 % cream = 15 *parts*
X g of 20 % cream = 7 *parts*

$$\boldsymbol{X} \text{ g of 20 \% cr.} = \frac{\text{250 g of 12 \% cr.} \times 7\ \textit{parts}}{15\ \textit{parts}}$$

X g of 20 % cr. ≈ **116,7 g**

250 g of 12 % cream = 15 *parts*
X g of 5 % cream = 8 *parts*

$$\boldsymbol{X} \text{ g of 5 \% cr.} = \frac{\text{250 g of 12 \% cr.} \times 8\ \textit{parts}}{15\ \textit{parts}}$$

X g of 5 % cr. ≈ **133,3 g**

Therefore, to obtain **250 g of cream at 12%** (w/w), we need to mix:
116.7 g of 20% (w/w) cream + **133.3 g of 5%** (w/w) cream

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Use alligation medial to validate your results from alligation alternate:

+	**133,3 g** x 5 %	=	**666,5 p** +
	116,7 g x 20 %	=	**2334 p**
	250 g	÷	**3000,5 p**

= **12%**

Practical Application!

1. How many grams of zinc oxide ointment at 3% (w/w) and 15% (w/w) will be necessary to make 100 g of zinc oxide ointment at 10% (w/w)?
2. Again, regarding zinc oxide, what would be the final concentration, expressed as a percentage (w/w), obtained after mixing 100 g of zinc oxide at 3% (w/w), 200 g at 5% (w/w), and 300 g at 20% (w/w)?
3. Which type of alligation is used to find the necessary quantities of different ingredients to obtain a final product at a certain concentration: alligation alternate or alligation medial?
4. You have a tube of benzocaine ointment at 20% (w/w) and a base ointment with no active ingredient. How much of each of these ingredients will you use to prepare 30 g of benzocaine at 2.5% (w/w)?
5. You are asked to mix 3 bottles of alcohol together. One contains ¼ L at 90% (v/v), another 210 mL at 20% (v/v), and the last 125 mL at 30% (v/v). What will be the final concentration as a percentage (v/v) after this mix?
6. In a non-pharmacy context, how many mL of 1% milk and 3.25% milk would be needed to obtain ½ L of 2% milk?
7. Returning to the field of pharmacy. How many mL of a syrup containing 85% (w/v) sugar and another containing 60% (w/v) sugar need to be mixed to obtain 600 mL of syrup containing 80% (w/v) sugar?
8. How many mL of a phenobarbital elixir at 20 mg/5 mL and at 30 mg/5 mL need to be used to prepare 1 L of elixir containing 4.6 mg of phenobarbital per mL (4.6 mg/mL)?
9. You have vials of metoclopramide at 5 mg/mL and sterile water for injection. You need to prepare 25 mL of metoclopramide at 0.5 mg/mL. How many mL of each will you use? Different methods can be used to perform this calculation; to practice this type of calculation, use alternate alligation.

Solutions

1. Use 41.7 g of 3% ointment and 58.3 g of 15% ointment.
2. The final concentration will be 12.17% (w/w).
3. Alligation alternate.
4. Use 3.75 g of 20% ointment and 26.25 g of base without active ingredient.
5. The final concentration will be 52.05% (v/v).
6. Use 277.78 mL of 1% milk and 222.22 mL of 3.25% milk.
7. Use 480 mL of syrup at 85% and 120 mL of syrup at 60%.
8. Use 700 mL of the elixir at 20 mg/5 mL and 300 mL of the elixir at 30 mg/5 mL.
9. Use 2.5 mL of the solution at 5 mg/mL and 22.5 mL of sterile water.

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