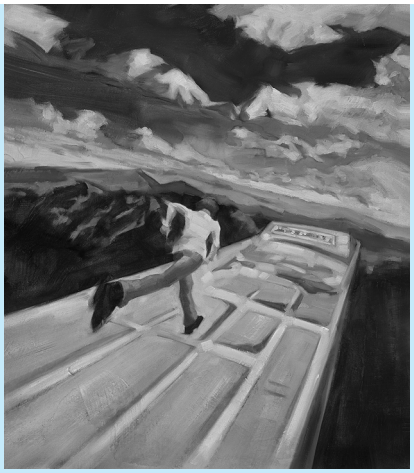


CHAPTER 7

Alligations

Learning Objectives

After completing this chapter, you should be able to:

- Understand when to use the alligation principle for calculations.
- Calculate a variety of alligation-related problems.

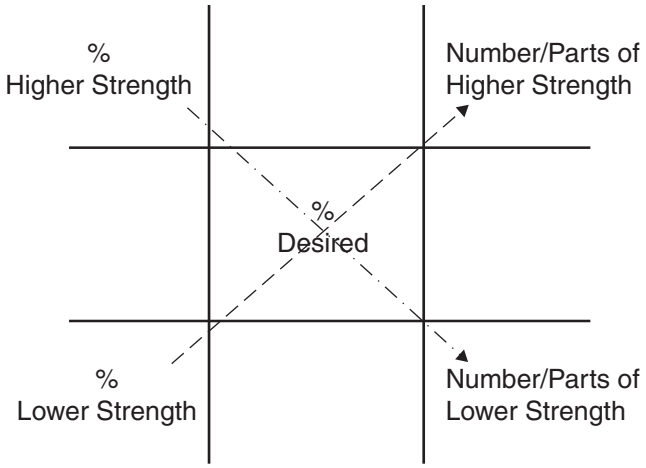
INTRODUCTION

Alligations are used when mixing two products with different percent strengths of the same active ingredient. The strength of the final product will fall between the strengths of each original product.

Solving Alligations

You can use the alligation method to determine how many parts of the same product, with different strengths, you will need to create the final strength requested. Further, you can calculate exactly how many milliliters or grams you need of each beginning product.

The Alligation Grid



Alligation Tips

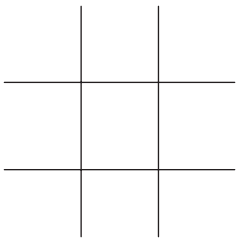
- Solvents and diluents such as water, vanishing cream base, and white petrolatum are considered a percent strength of zero.
- Liquids, including solutions, syrups, elixirs, and even lotions, are expressed in milliliters.
- Solids are expressed in grams. This would include powders, creams, and ointments.
- The alligation formula requires that you express the strength as a percentage when setting up the problem. You would have to convert a ratio strength given in the question to a percent strength.
- When writing percents or using decimals, always use a leading zero: 0.25%. This helps prevent errors in interpretation. It would be a terrible error and possibly even fatal to dispense something in 25% that was really supposed to be 0.25%.
- 1 fl. oz. = 29.57 mL. This is commonly rounded to 30 mL.
- 1 avoirdupois oz. = 28.35 g. This measurement, used for solids, is also commonly rounded to 30 g.

EXAMPLE 7.1 Rx—Prepare 120 g of a 2% hydrocortisone ointment using a 1% ointment and a 2.5% ointment.

Let's look at the information that has been provided.

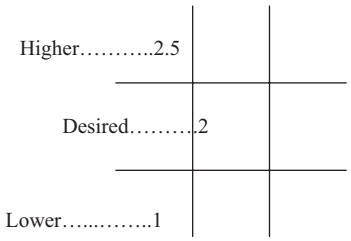
2.5%	Higher Strength
1%	Lower Strength
2%	Desired Strength
120 g	Desired Quantity

First, draw the alligation grid.

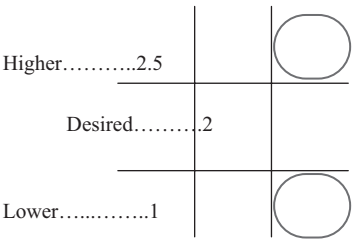


Now, fill in the alligation grid with the information that has been provided in the problem.

- The higher strength goes in the top left box.
- The lower strength goes in the bottom left box.
- The desired strength goes in the center box.

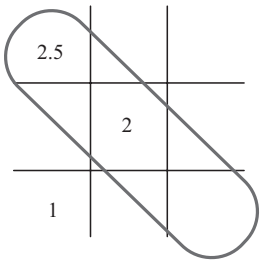


Next, we will calculate the numbers that should go into the top right and bottom right boxes.



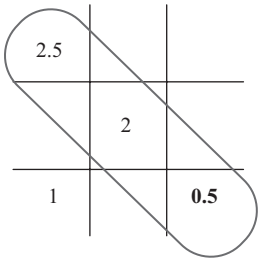
This is done by working diagonally and taking the difference between the two numbers already in place.

Let's look at the first diagonal, which contains 2.5 and 2. The difference of these two numbers will go in the bottom right box.

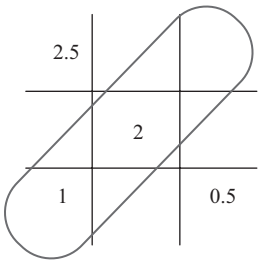


The difference between 2.5 and 2 is 0.5, so 0.5 goes in the bottom right box.

$$2.5 - 2 = 0.5$$



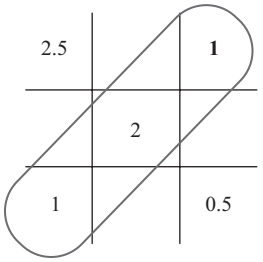
Now, we can work on the other diagonal, which contains 1 and 2. The difference of these two numbers will go into the top right box.



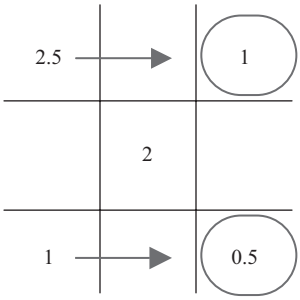
The difference between 1 and 2 is 1, so 1 goes in the top right box.

$$1 - 2 = -1$$

Only positive numbers can go into the alligation grid, so −1 is changed to 1.

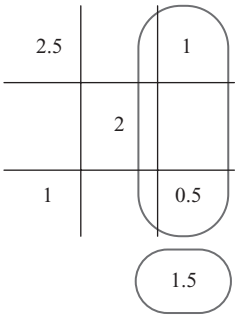


The numbers on the right-hand side of the alligation grid represent the number of parts per ingredient, when read straight across. This means that there should be 1 part of the 2.5% ointment and 0.5 parts of the 1% ointment to make the 2% ointment.



Now, by adding the numbers in the right column, we can determine the total number of parts necessary. In other words,

$$1 \text{ part } (2.5\%) + 0.5 \text{ part } (1\%) = 1.5 \text{ parts total}$$



Now that we have determined the number of parts needed for each ingredient and the total number of parts to be used, we can set these up as proportions.

$$\frac{\text{parts needed}}{\text{total parts}}$$

2.5% ointment

$$\frac{1 \text{ part}}{1.5 \text{ parts}} \quad \text{or} \quad \frac{1}{1.5}$$

1% ointment

$$\frac{0.5 \text{ part}}{1.5 \text{ parts}} \quad \text{or} \quad \frac{0.5}{1.5}$$

Finally, we can take the proportion of parts needed of each ointment and multiply it by the desired quantity to determine the quantity of each ingredient needed.

2.5% ointment

$$\frac{120 \text{ g} \times 1}{1.5} = 80 \text{ g}$$

1% ointment

$$\frac{120 \text{ g} \times 0.5}{1.5} = 40 \text{ g}$$

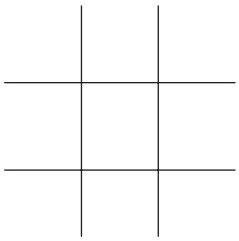
So, we would combine 80 g of the 2.5% ointment and 40 g of the 1% ointment to produce 120 g of a 2% ointment.

EXAMPLE 7.2 Rx—Prepare 90 g of triamcinolone 0.05% cream. In stock, you have 454 g each of triamcinolone 0.025% cream and triamcinolone 0.1% cream.

Let's look at the information that has been provided.

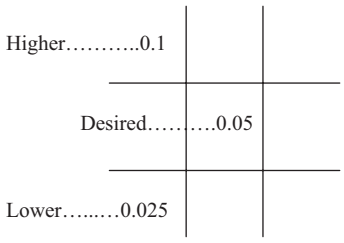
0.1%	Higher Strength
0.025%	Lower Strength
0.05%	Desired Strength
90 g	Desired Quantity

First, draw the alligation grid.

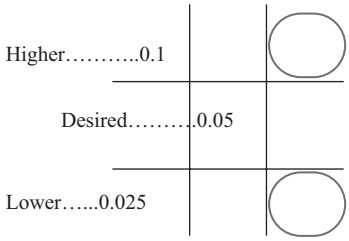


Now, fill in the alligation grid with the information that has been provided in the problem.

- The higher strength goes in the top left box.
- The lower strength goes in the bottom left box.
- The desired strength goes in the center box.

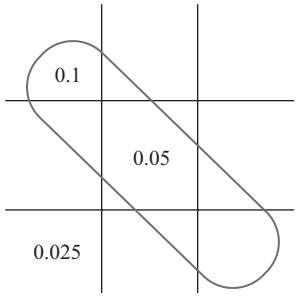


Next, we will calculate the numbers that should go into the top right and bottom right boxes.



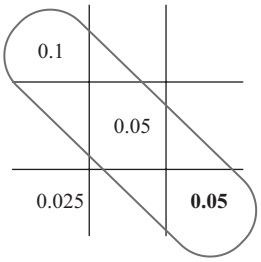
This is done by working diagonally and taking the difference between the two numbers already in place.

Let's look at the first diagonal, which contains 0.1 and 0.05. The difference of these two numbers will go in the bottom right box.

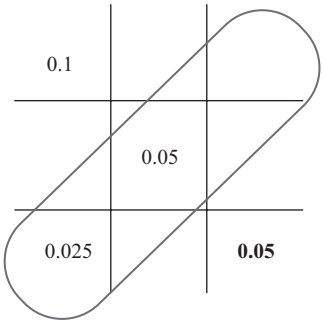


The difference between 0.1 and 0.05 is 0.5, so 0.05 goes in the bottom right box.

$$0.1 - 0.05 = 0.05$$



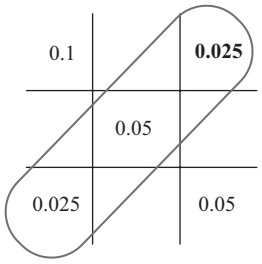
Now, we can work on the other diagonal, which contains 0.025 and 0.05. The difference of these two numbers will go into the top right box.



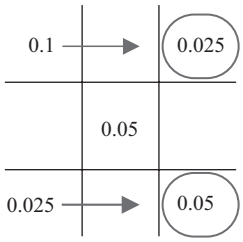
The difference between 0.025 and 0.05 is 0.025, so 0.025 goes in the top right box.

$$0.025 - 0.05 = -0.025$$

Remember, only positive numbers can go into the alligation grid, so −0.025 is changed to 0.025.

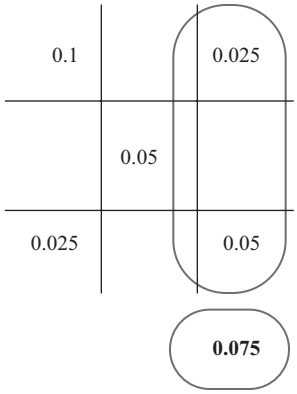


The numbers on the right-hand side of the alligation grid represent the number of parts per ingredient, when read straight across. This means that there should be 0.025 part of the 0.1% cream and 0.05 part of the 0.025% cream to make the 0.05% cream.



Now, by adding the numbers in the right column, we can determine the total number of parts necessary. In other words,

0.025 part (0.1%) + 0.05 part (0.025%) = 0.075 part total



Now that we have determined the number of parts needed for each ingredient and the total number of parts to be used, we can set these up as proportions.

$$\frac{\text{parts needed}}{\text{total parts}}$$

0.1% cream

$$\frac{0.025 \text{ part}}{0.075 \text{ part}} \quad \text{or} \quad \frac{0.025}{0.075}$$

0.025% cream

$$\frac{0.05 \text{ part}}{0.075 \text{ part}} \quad \text{or} \quad \frac{0.05}{0.075}$$

Finally, we can take the proportion of parts needed of each cream and multiply it by the desired quantity to determine the quantity of each ingredient needed.

0.1% cream

$$\frac{90 \text{ g} \times 0.025}{0.075} = 30 \text{ g}$$

0.025% cream

$$\frac{90 \text{ g} \times 0.05}{0.075} = 60 \text{ g}$$

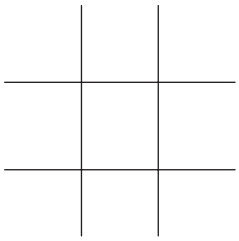
So, we would combine 30 g of the 0.1% cream and 60 g of the 0.025% cream to produce 90 g of a 0.5% cream.

EXAMPLE 7.3 Rx—How much of a 2.5% cream and a 0.5% cream would be required to compound 100 g of a 1% cream?

Let's look at the information that has been provided.

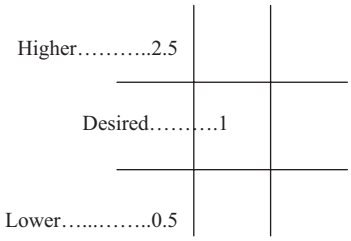
2.5%	Higher Strength
0.5 %	Lower Strength
1%	Desired Strength
100 g	Desired Quantity

First, draw the alligation grid.

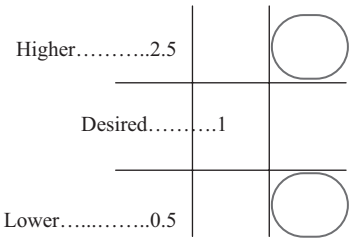


Now, fill in the alligation grid with the information that has been provided in the problem.

- The higher strength goes in the top left box.
- The lower strength goes in the bottom left box.
- The desired strength goes in the center box.

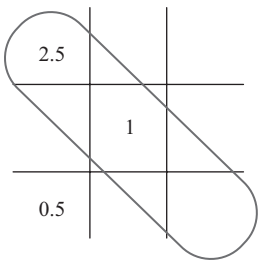


Next, we will calculate the numbers that should go into the top right and bottom right boxes.



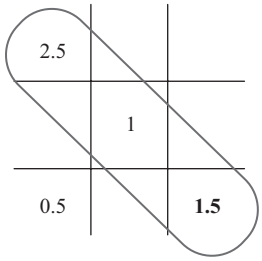
This is done by working diagonally and taking the difference between the two numbers already in place.

Let's look at the first diagonal, which contains 2.5 and 1. The difference of these two numbers will go in the bottom right box.

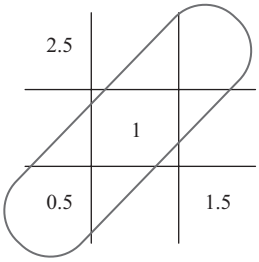


The difference between 2.5 and 1 is 1.5, so 1.5 goes in the bottom right box.

$$2.5 - 1 = 1.5$$



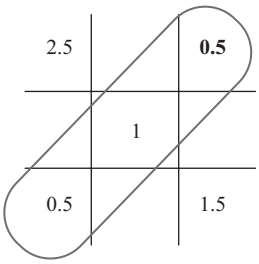
Now, we can work on the other diagonal, which contains 0.5 and 1. The difference of these two numbers will go into the top right box.



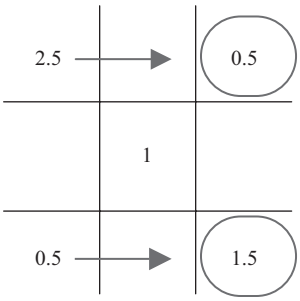
The difference between 0.5 and 1 is 0.5, so 0.5 goes in the top right box.

$$0.5 - 1 = -0.5$$

Remember, only positive numbers can go into the alligation grid, so −0.5 is changed to 0.5.

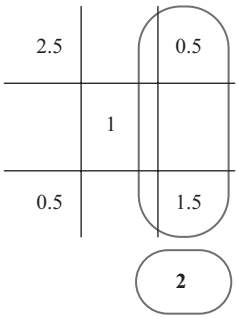


The numbers on the right-hand side of the alligation grid represent the number of parts per ingredient, when read straight across. This means that there should be 0.5 part of the 2.5% cream and 1.5 parts of the 0.5% cream to make the 1% cream.



Now, by adding the numbers in the right column, we can determine the total number of parts necessary. In other words,

0.5 part (2.5%) + 1.5 parts (0.5%) = 2 parts total



Now that we have determined the number of parts needed for each ingredient and the total number of parts to be used, we can set these up as proportions.

$$\frac{\text{parts needed}}{\text{total parts}}$$

2.5% cream

$$\frac{0.5 \text{ part}}{2 \text{ parts}} \quad \text{or} \quad \frac{0.5}{2}$$

0.5% cream

$$\frac{1.5 \text{ parts}}{2 \text{ parts}} \quad \text{or} \quad \frac{1.5}{2}$$

Finally, we can take the proportion of parts needed of each cream and multiply it by the desired quantity to determine the quantity of each ingredient needed.

2.5% cream

$$\frac{100 \text{ g} \times 0.5}{2} = 25 \text{ g}$$

0.5% cream

$$\frac{100 \text{ g} \times 1.5}{2.0} = 75 \text{ g}$$

So, we would combine 25 g of the 2.5% cream and 75 g of the 0.5% cream to produce 100 g of a 1% cream.

EXAMPLE 7.4 Rx—Prepare 500 mL of a 7.5% dextrose solution using SWFI and D10W.

Let's look at the information that has been provided.

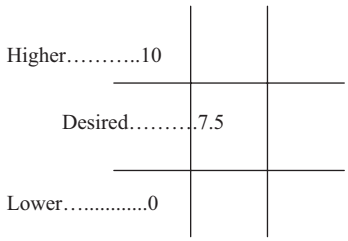
10%	Higher Strength
0%	Lower Strength
7.5%	Desired Strength
500 mL	Desired Quantity

D10W stands for dextrose 10% in water, thus making it a 10% strength.

Don't forget that bases, such as SWFI are 0% strength, since they contain no active ingredient.

Now, fill in the alligation grid with the information that has been provided in the problem.

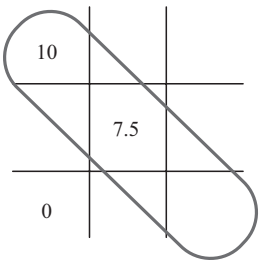
- The higher strength goes in the top left box.
- The lower strength goes in the bottom left box.
- The desired strength goes in the center box.



Next, we will calculate the numbers that should go into the top right and bottom right boxes.

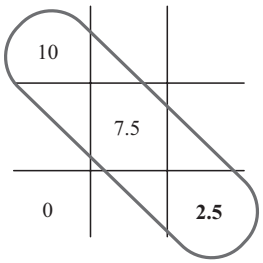
This is done by working diagonally and taking the difference between the two numbers already in place.

Let's look at the first diagonal, which contains 10 and 7.5. The difference of these two numbers will go in the bottom right box.

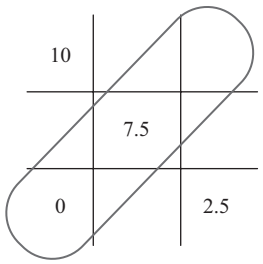


The difference between 10 and 7.5 is 2.5, so 2.5 goes in the bottom right box.

$$10 - 7.5 = 2.5$$



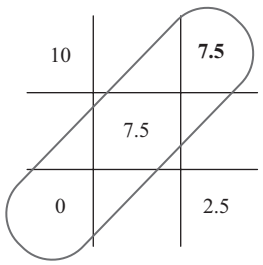
Now, we can work on the other diagonal, which contains 0 and 7.5. The difference of these two numbers will go into the top right box.



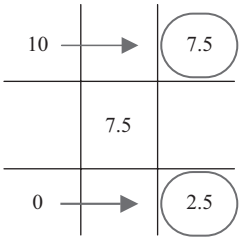
The difference between 0 and 7.5 is 7.5, so 7.5 goes in the top right box.

$$0 - 7.5 = -7.5$$

Remember, any negative number must be changed to a positive number to be used in the grid.

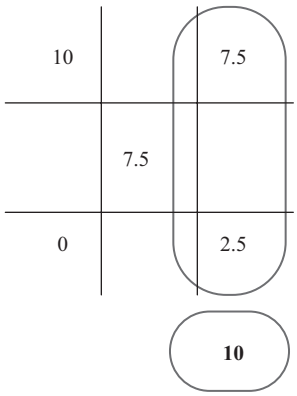


The numbers on the right-hand side of the alligation grid represent the number of parts per ingredient, when read straight across. This means that there should be 7.5 parts of the D10W and 2.5 parts of the SWFI to prepare a 7.5% dextrose solution.



Now, by adding the numbers in the right column, we can determine the total number of parts necessary. In other words,

7.5 parts (10%) + 2.5 parts (0%) = 10 parts total



Now that we have determined the number of parts needed for each ingredient and the total number of parts to be used, we can set these up as proportions.

$$\frac{\text{parts needed}}{\text{total parts}}$$

D10W

$$\frac{7.5 \text{ parts}}{10 \text{ parts}} \quad \text{or} \quad \frac{7.5}{10}$$

SWFI

$$\frac{2.5 \text{ parts}}{10 \text{ parts}} \quad \text{or} \quad \frac{2.5}{10}$$

Finally, we can take the proportion of parts needed of each cream and multiply it by the desired quantity to determine the quantity of each ingredient needed.

D10W

$$\frac{500 \text{ mL} \times 7.5}{10} = 375 \text{ mL}$$

SWFI

$$\frac{500 \text{ mL} \times 2.5}{10} = 125 \text{ mL}$$

So, we would combine 375 mL of the D10W and 125 mL of the SWFI to prepare 500 mL of a 7.5% dextrose solution.

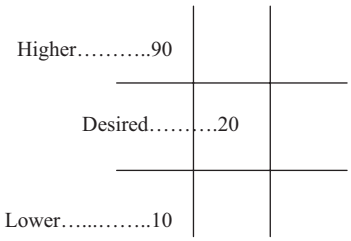
EXAMPLE 7.5 Rx—Prepare 1 L of a 20% alcohol solution using a 90% alcohol and a 10% alcohol.

Let's look at the information that has been provided.

90%	Higher Strength
10%	Lower Strength
20%	Desired Strength
1 L (1000 mL)	Desired Quantity

Now, fill in the alligation grid with the information that has been provided in the problem.

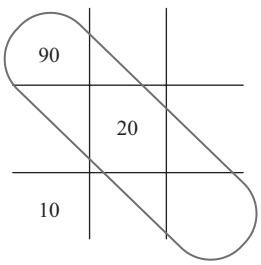
- The higher strength goes in the top left box.
- The lower strength goes in the bottom left box.
- The desired strength goes in the center box.



Next, we will calculate the numbers that should go into the top right and bottom right boxes.

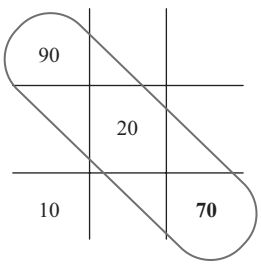
This is done by working diagonally and taking the difference between the two numbers already in place.

Let's look at the first diagonal, which contains 90 and 20. The difference of these two numbers will go in the bottom right box.

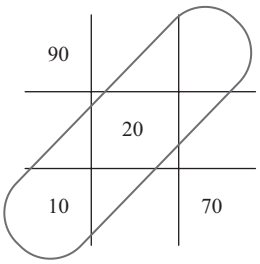


The difference between 90 and 20 is 70, so 70 goes in the bottom right box.

$$90 - 20 = 70$$



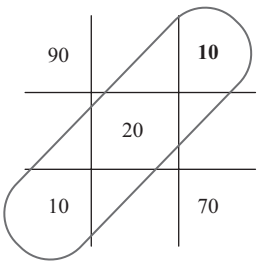
Now, we can work on the other diagonal, which contains 10 and 20. The difference of these two numbers will go into the top right box.



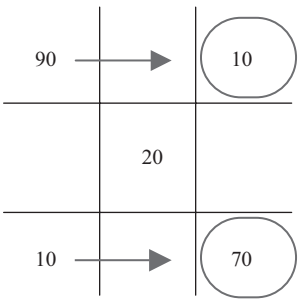
The difference between 10 and 20 is 10, so 10 goes in the top right box.

$$10 - 20 = -10$$

Remember, any negative number must be changed to a positive number to be used in the grid.

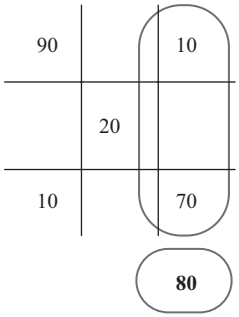


The numbers on the right-hand side of the alligation grid represent the number of parts per ingredient, when read straight across. This means that there should be 10 parts of the 90% alcohol and 70 parts of the 10% alcohol to prepare a 20% alcohol solution.



Now, by adding the numbers in the right column, we can determine the total number of parts necessary. In other words,

10 parts (90%) + 70 parts (10%) = 80 parts total



Now that we have determined the number of parts needed for each ingredient and the total number of parts to be used, we can set these up as proportions.

$$\frac{\text{parts needed}}{\text{total parts}}$$

90% alcohol

$$\frac{10 \text{ parts}}{80 \text{ parts}} \quad \text{or} \quad \frac{10}{80}$$

10% alcohol

$$\frac{70 \text{ parts}}{80 \text{ parts}} \quad \text{or} \quad \frac{70}{80}$$

Finally, we can take the proportion of parts needed of each cream and multiply it by the desired quantity to determine the quantity of each ingredient needed.

90% alcohol

$$\frac{1000 \text{ mL} \times 10}{80} = 125 \text{ mL}$$

10% alcohol

$$\frac{1000 \text{ mL} \times 70}{80} = 875 \text{ mL}$$

So, we would combine 125 mL of the 90% alcohol and 875 mL of the 10% alcohol to prepare 1 L of a 20% alcohol.

PRACTICE PROBLEMS 7.1

Calculate the following alligations.

1. Rx silver nitrate 0.25% solution 1 L

   You have a gallon of silver nitrate 1% stock solution, which you will dilute with distilled water. How many milliliters of each will you need to make the final product? Note that the percent strength of water is zero. _____ _____

2. Rx soaking solution 1:100 1 L

   You have a 1:25 stock solution and water. How many milliliters of each will you need to make the final product? _____

   _____

3. Rx coal tar 5% ointment 120 g

   You have coal tar 10% ointment and coal tar 2% ointment. How many grams of each will you use to prepare the final product?

   _____

4. You are instructed to prepare 454 g of a 15% ointment. In stock you have 5% and 30%. How much of each will you need to use to make the order? _____

5. Rx—Prepare 480 mL of a 1:30 solution using a 1:10 solution and a 1:50 solution.

   What quantities will be used of each stock solution to make the 1:30 solution? _____

6. You need to prepare 80 g of a 9% cream using a 20% stock cream and a cream base. How much are needed of each? _____

7. You are asked to prepare 1 L of a 1:300 soaking solution, using a stock 1:500 soaking solution and distilled water. How much of each will you need to use? _____

8. How much SWFI would need to be added to 500 mL stock normal saline (0.9% NaCL) to produce a 0.45% sodium chloride solution?

   _____

9. Rx alcohol 30%

   How many milliliters of 90% alcohol should you add to 25 mL of 10% alcohol to make 30% alcohol? _____

10. Rx hydrocortisone 2% ointment

    How many grams of petrolatum should you add to 30 g of hydrocortisone 2.5% ointment to reduce its strength to 2.0%? The percent strength of petrolatum is zero. _____

11. Rx normal saline

    How many milliliters of water must you add to 500 mL of a 10% stock solution of sodium chloride to make a batch of normal saline (sodium chloride 0.9% solution)? _____

12. Rx ichthammol 5% ointment

    How many grams of ichthammol 10% ointment should you add to 20 g of ichthammol 2% ointment to make ichthammol 5% ointment?

    _____

13. Rx benzalkonium chloride 1:1000 solution

    How many milliliters of water should you add to 50 mL of benzalkonium chloride 0.25% solution to prepare the order?

    _____

14. Rx zinc oxide 10% ointment 45 g

    How many grams of zinc oxide 20% ointment and zinc oxide 5% ointment should you mix to prepare the order? _____

    _____

15. Rx aluminum acetate 1:400 solution 1 gallon

    How many milliliters of Burrow's solution (aluminum acetate 5%) should you use to prepare the order? _____

16. Rx histamine phosphate 1:10,000 solution 10 mL

    How many milliliters of a histamine phosphate 1:10 solution do you need to prepare the order? _____

17. Rx benzocaine 5% ointment 2 oz.

    How many grams of benzocaine 2% ointment should you mix with 22.5 g of benzocaine 10% ointment to prepare the order? _____

18. When using a 0.5% cream and a 2% cream to produce a 1.25% cream, how many parts of each are needed? _____

19. In what proportion would you add SWFI with D10W to produce D6W?

    _____

20. In what proportion should you add a 1:20 soaking solution with distilled water to create a 1:50 solution? _____

SUMMARY

In certain situations, a pharmacy must use the alligation method to combine two varying strengths of a drug or combine a drug with a base or diluent to achieve the prescribed strength. While these calculations can be confusing at first, once you master the alligation grid you should be able to perform these calculations easily.

CHAPTER 7

CHAPTER REVIEW QUESTIONS

MULTIPLE CHOICE

1. How much 20% cream should you add to 26 g of 1% cream to make a 4% cream?

   _____

   a. 6.00 g
   b. 5.20 g
   c. 4.88 g
   d. 3.00 g

2. How much 25% stock solution and distilled water will you need to make 1 L of a 1 : 400 solution? _____

   a. 10 mL of the 25% solution and 990 mL of water
   b. 100 mL of the 25% solution and 900 mL of water
   c. 990 mL of the 25% solution and 10 mL of water
   d. 900 mL of the 25% solution and 10 mL of water

3. How much 10% cream and a 0.5% cream will you need to prepare 120 g of a 2.5% cream?

   _____

   a. 20 g of the 10% cream and 100 g of the 0.5% cream
   b. 100 g of the 10% cream and 20 g of the 0.5% cream
   c. 25 g of the 10% cream and 95 g of the 0.5% cream
   d. 95 g of the 10% cream and 25 g of the 0.5% cream

4. How much povidone iodine 20% solution and water will you need to make 500 mL of a povidone iodine 3% rinse? _____

   _____

   a. 75 mL of the 20% solution and 425 mL of water
   b. 425 mL of the 20% solution and 25 mL of water
   c. 20 mL of the 20% solution and 480 mL of water
   d. 480 mL of the 20% solution and 20 mL of water

5. How much lidocaine 0.5% topical gel should you mix with lidocaine 10% topical gel to make 15 g of a lidocaine 2% topical gel?

   _____

   a. 2.4 g
   b. 5.0 g
   c. 9.5 g
   d. 12.6 g

6. How much 1 : 25 solution and 1 : 500 solution should you mix to make 1 L of a 1 : 250 soaking solution? _____

   a. 947 mL of the 1 : 25 solution and 53 mL of the 1 : 500 solution
   b. 53 mL of the 1 : 25 solution and 947 mL of the 1 : 500 solution
   c. 250 mL of the 1 : 25 solution and 750 of the 1 : 500 solution
   d. 750 mL of the 1 : 25 solution and 250 mL of the 1 : 500 solution

7. Convert 50% to a ratio strength. _____

   a. 1 : 2 **c.** 1 : 6
   b. 1 : 4 **d.** 1 : 8

8. How much NaCl 10% stock solution should you add to 100 mL of NaCl 0.45% solution to make normal saline? _____

   a. 1 mL **c.** 5 mL
   b. 2 mL **d.** 10 mL

9. How many grams of 0.1% cream should you mix with 12 g of 12% cream to make a 6% cream? _____

   a. 10.4 g **c.** 24 g
   b. 12.2 g **d.** 33 g

10. How many parts of each of a 1% product and a 3% product do you need to make a 2.5% product? _____ _____

    a. 2.5 parts of the 1% product and 1 part of the 3% product

    b. 1 part of the 1% product and 2.5 parts of the 3% product

    c. 1.5 parts of the 1% product and 0.5 part of the 3% product

    d. 0.5 part of the 1% product and 1.5 parts of the 3% product

TRUE OR FALSE

11. When using the alligation method, you must consider three different percent strengths: the beginning strength of each ingredient and the final strength. _____

    a. true **b.** false

12. When using the alligation method, the final strength will be a value between the beginning two strengths. _____

    a. true **b.** false

13. Distilled water, with a percent strength of zero, is sometimes used as a beginning ingredient in alligation problems. _____

    a. true **b.** false

14. When setting up an alligation, you should convert any ratio strengths given to percent strengths before setting up the formula. _____

    a. true **b.** false

15. Amounts needed of powders, creams, and ointments are expressed in milligrams. _____

    a. true **b.** false

SHORT ANSWER

16. Describe the principle of alligations.

    _____

17. List three tips for performing alligations.

    _____

    _____

    _____

18. Describe how to verify your answer when solving alligations.

    _____

19. Describe how to convert a ratio strength to a percent strength.

    _____

20. Describe how to convert a percent strength to a ratio strength.

    _____