

Chapter 10

Dilution and Concentration

OBJECTIVES

Upon completion of this chapter, the technician student will be able to:

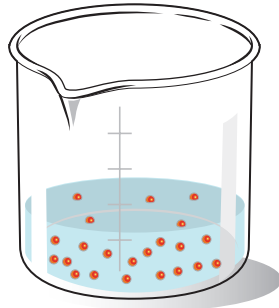
- Describe the relationship of active ingredients and diluents if the amount of active ingredient remains constant and the amount of diluent is increased or decreased.
- Determine the percent strength and ratio strength of a given product when the active ingredient remains constant and the amount of diluent is increased or decreased.
- Determine the volume of solution of a desired strength given a specified quantity of any given strength.
- Determine the volume of a specified stock solution needed to prepare a given solution.
- Determine the quantity of an active ingredient in a specified amount of solution needed to prepare a given solution.
- Define the alligation methods of problem solving.
- Use the alligation methods (alligation alternate and alligation medial) to determine the percent strength of alcohol mixtures.
- Use the alligation methods (alligation alternate and alligation medial) to determine relative amounts of components mixed together to make a mixture of a required strength.

TERMS

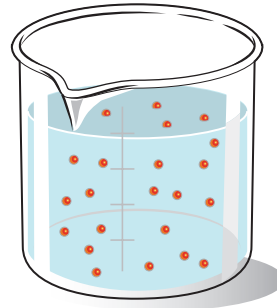
- Alligation
- Alligation alternate
- Alligation medial
- Diluent
- Stock solution

diluent A substance added to a pharmaceutical product to reduce its strength, or dilute it. A diluent most often has no drug substance in it; examples are sterile water and petrolatum.

Chapter 9 addresses problems arising from the quantitative relationship between specific ingredients and the pharmaceutical preparation as a whole. This chapter introduces problems of a slightly different character: those that arise when pharmaceutical preparations are *diluted* (by the addition of **diluent** or by admixture with solutions or mixtures of lower strength) or are *concentrated* (by the addition of active ingredient or by admixture with solutions or mixtures of greater strength).



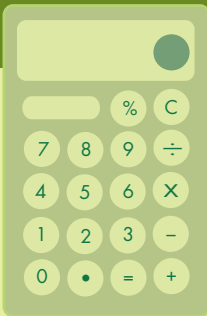
Pharmaceutical preparation before dilution



Pharmaceutical preparation after dilution (same amount of active drug although the volume has doubled)

Problems such as these sometimes seem complicated and difficult. Solving some of these calculations requires a series of steps. Understanding the basic concepts of dilution and concentration uncomplicates these problems.

Many problems can be solved in several ways. The best way is not necessarily the shortest: the best way is the one *that is clearly understood* and that leads to the correct answer.



Rules to Simplify the Calculation

These two rules, wherever they may be applied, greatly simplify the calculation:

1. *When ratio strengths are given, convert them to percentage strengths before setting up a proportion.* It is much easier to solve using a decimal or percent, like 10 (%) : 0.2 (%) than a fraction represented by the ratio like $\frac{1}{10} : \frac{1}{500}$.
2. *Whenever proportional parts enter into a calculation, reduce them to lowest terms.* Instead of calculating with a ratio like 25 (parts) : 75 (parts), simplify it to 1 (part) : 3 (parts).

Relationship Between Strength and Total Quantity

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. So if 50 mL of a solution containing 10 g of active ingredient with a strength of 20% or 1 : 5 w/v is 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, then, *the amount of active ingredient remains constant, any change in the quantity of a solution or mixture of solids is inversely proportional to the percentage or ratio strength*; that is, the percentage or ratio strength decreases as the quantity increases, and vice versa. In other words, if the amount of active ingredient remains the same and the volume gets larger, the concentration gets smaller. Likewise, if the amount of active ingredient remains the same and the volume gets smaller, the concentration increases.

This relationship is generally true except for volume-in-volume and weight-in-volume solutions containing components that contract when mixed together. It is not possible to add the volume of ingredients and get the total volume of the final product in all cases. It is possible when mixing solids.

Problems in this chapter generally may be solved by one of the following methods:

1. Inverse proportion:

$$\frac{C_1}{C_2} = \frac{Q_2}{Q_1}$$

where C = concentration and Q = quantity.

2. The following formula:

$$(\text{quantity 1}) \times (\text{concentration 1}) = (\text{quantity 2}) \times (\text{concentration 2})$$

That is,

$$Q_1 \times C_1 = Q_2 \times C_2$$

3. Determining the quantity of active constituent (solute) needed and then calculating the quantity of the available solution (usually concentrated or stock solution) that will provide the needed amount of constituent.

For most situations the student technician is encouraged to use the formula method of solving these dilution and concentration problems. Sometimes the third method is the easiest of the three, usually when the strength of the product is very small and the technician is using a prepared strength available in a vial or ampul. Examples of these are detailed later in the chapter. In the formula method the second quantity and second concentration are always that of the final product, not of the active ingredient or diluent.

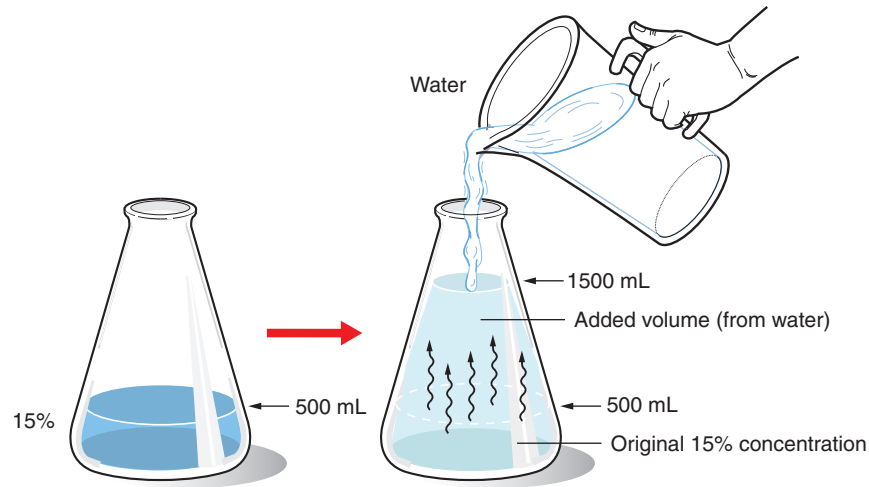
Dilution and Concentration of Liquids

Determination of Percentage or Ratio Strength

Calculating the percentage or ratio strength of a solution made by diluting or concentrating (by evaporation) a solution of given quantity and strength entails the following.

Examples:

If 500 mL of a 15% v/v solution of methyl salicylate in alcohol is diluted to 1500 mL, what is the percentage strength v/v?



$$Q1 \times C1 = Q2 \times C2$$

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

$$X = 5\%, \text{ answer}$$

Solve by Inverse Proportion:

$$\frac{1500 \text{ mL}}{500 \text{ mL}} = \frac{15\%}{X\%}$$

$$X = 5\%, \text{ answer}$$

Calculate the Active Ingredient:

500 mL of 15% v/v solution contains 75 mL of methyl salicylate (active ingredient).

$$\frac{1500 \text{ mL}}{75 \text{ mL}} = \frac{100\%}{X\%}$$

$$X = 5\%, \text{ answer}$$

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

$$1:20 = 5\%$$

$$Q1 \times C1 = Q2 \times C2$$

$$50 \text{ (mL)} \times 5 \text{ (\%)} = 1000 \text{ (mL)} \times (\%)$$

$$X = 0.25\% = 1:400, \text{ answer}$$

Solve by Inverse Proportion:

$$\frac{1000 \text{ mL}}{50 \text{ mL}} = \frac{5\% \cdot 1000 \text{ mL}}{X\%} = \frac{1/20}{50 \text{ mL } X}$$

$$X = 0.25\% = 1:400, \text{ answer} \quad X = 1/400 = 1:400, \text{ answer}$$

Calculate the Active Ingredient:

50 mL of a 1:20 solution contains 2.5 g of aluminum acetate.

$$\frac{2.5 \text{ g}}{1 \text{ g}} = \frac{1000 \text{ mL}}{X \text{ mL}}$$

$$X = 400 \text{ mL}$$

Ratio strength = 1 : 400, *answer*

**Critical Thinking 10.1**

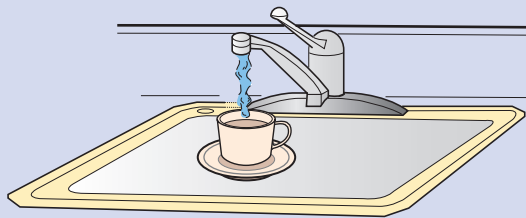
Dilution of a solid or liquid does *not* entail adding more drug. Therefore, the amount of drug in the diluted product is the *same*; only the volume is larger.

If a cup of coffee is too strong for a person's taste, the person may add water to *dilute* it. No additional coffee is used.

Strong coffee



Diluting strong coffee



Because no additional coffee was added,
the drink is now less concentrated.

Determining Amount of Solution of a Desired Strength

Calculating the amount of solution of a desired strength that can be made by diluting or concentrating (by evaporation) a specified quantity of a solution of given strength involves the following.

Examples:

How much 10% w/w (in grams) ammonia solution can be made from 1800 g of 28% w/w strong ammonia solution?

$$Q1 \times C1 = Q2 \times C2$$

$$1800 \text{ (g)} \times 28 \text{ (\%)} = X \text{ (g)} \times 10\%$$

$$X = 5040 \text{ g, answer}$$

Solve by Inverse Proportion:

$$\frac{10\%}{28\%} = \frac{1800 \text{ g}}{X \text{ g}}$$

$$X = 5040 \text{ g, answer}$$

Calculate the Active Ingredient:

1800 g of 28% ammonia water contains 504 g of ammonia (100%).

$$\frac{10\%}{100\%} = \frac{504 \text{ g}}{X \text{ g}}$$

$$X = 5040 \text{ g, answer}$$

How much (in milliliters) of a 1 : 5000 w/v solution of phenylmercuric acetate can be made from 125 mL of a 0.2% solution?

$$1 : 5000 = 0.02\%$$

$$Q1 \times C1 = Q2 \times C2$$

$$125 \text{ (mL)} \times 0.2 \text{ (\%)} = X \text{ (mL)} \times 0.02 \text{ (\%)}$$

$$X = 1250 \text{ mL, answer}$$

Solve by Inverse Proportion:

$$\frac{0.02\%}{0.2\%} = \frac{125 \text{ mL}}{X \text{ mL}}$$

$$X = 1250 \text{ mL, answer}$$

Or

$$0.2\% = 1 : 500$$

$$\frac{1/5000}{1/500} = \frac{125 \text{ mL}}{X \text{ mL}}$$

$$X = 1250 \text{ mL, answer}$$

Calculate the Active Ingredient:

125 mL of a 0.2% solution contains 0.25 g of phenylmercuric acetate

$$\frac{1 \text{ g}}{0.25 \text{ g}} = \frac{5000 \text{ mL}}{X \text{ mL}}$$

$$X = 1250 \text{ mL, answer}$$

Stock Solutions

Stock solutions are solutions of known concentration that are prepared by the pharmacist or technician for convenience in dispensing. They are usually strong solutions from which weaker ones may be made conveniently. When correctly prepared, these solutions enable the pharmacist to obtain small quantities of medicinal substances that are to be dispensed in solution.

Stock solutions usually are prepared on a weight-in-volume basis, and their concentration is expressed as a ratio strength or less frequently as a percentage strength.

stock solution A solution of a known concentration prepared for the convenience of dispensing; usually a strong solution from which weaker ones can be made conveniently.

Amount of Solution Needed to Prepare Desired Solution

Calculating the amount of a solution of given strength that must be used to prepare a solution of desired amount and strength involves the following.

Examples:

How much (in milliliters) of a 1:400 w/v stock solution should be used to make 4 L of a 1:2000 w/v solution?

$$4 \text{ L} = 4000 \text{ mL}$$

$$1:400 = 0.25\% \quad 1:2000 = 0.05\%$$

$$Q1 \times C1 = Q2 \times C2$$

$$X \text{ (mL)} \times 0.25\% = 4000 \text{ mL} \times 0.05\%$$

$$X = 800 \text{ mL, answer}$$

Solve by Inverse Proportion:

$$\frac{0.25\%}{0.05\%} = \frac{4000 \text{ mL}}{X \text{ mL}}$$

$$X = 800 \text{ mL, answer}$$

Or

$$\frac{1/400}{1/2000} = \frac{4000 \text{ mL}}{X \text{ mL}}$$

$$X = 800 \text{ mL, answer}$$

Calculate the Active Ingredient:

4000 mL of a 1 : 2000 w/v solution requires 2 g of active constituent (solute), thus:

$$\frac{1 \text{ g}}{2 \text{ g}} = \frac{400 \text{ mL}}{X \text{ mL}}$$

$$X = 800 \text{ mL, answer}$$

How much (in milliliters) of a 1 : 400 w/v stock solution should be used in preparing 1 gal of a 1 : 2000 w/v solution?

$$1 \text{ gal} = 3785 \text{ mL}$$

$$1 : 400 = 0.25\% \quad 1 : 2000 = 0.05\%$$

$$Q1 \times C1 = Q2 \times C2$$

$$X \times 0.25\% = 3785 \text{ (mL)} \times 0.05 (\%)$$

$$X = 757 \text{ mL, answer}$$

Solve by Inverse Proportion:

$$\frac{0.25\%}{0.05\%} = \frac{3785 \text{ mL}}{X \text{ mL}}$$

$$X = 757 \text{ mL, answer}$$

Calculate the Active Ingredient:

To make 1 gal of a 1 : 2000 w/v solution requires 1.89 g of active constituent, thus:

$$\frac{1.89 \text{ g}}{1 \text{ g}} = \frac{X \text{ mL}}{400 \text{ mL}}$$

$$X = 756 \text{ mL, answer}$$

How much (in 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?

$$1 : 20,000 = 0.005\%$$

$$Q1 \times C1 = Q2 \times C2$$

$$X \times 1 (\%) = 4000 \text{ (mL)} \times 0.005 (\%)$$

$$X = 20 \text{ mL, answer}$$

Solve by Inverse Proportion:

$$\frac{1\%}{0.005\%} = \frac{4000 \text{ mL}}{X \text{ mL}}$$

$$X = 20 \text{ mL, answer}$$

Check:

1% stock solution contains	1 : 20,000 solution contains
$20 \text{ mL} \times 0.01 \rightarrow$	$\leftarrow 4000(\text{mL}) \times 0.00005$
0.2 g	
certified red dye	

Calculate the Active Ingredient:

To make 4000 mL of a 1 : 20,000 w/v solution requires 0.2 g of certified red dye, thus:

$$\frac{1 \text{ g}}{0.2 \text{ g}} = \frac{100 \text{ mL}}{X \text{ mL}}$$

$X = 20 \text{ mL}$, answer

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How much (in milliliters) of a 1 : 50 stock solution of ephedrine sulfate should be used in compounding the following prescription?

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Name: <u>Virginia Millhouse</u>	<u>678 Apple St.</u>
Rx: <i>Ephedrine sulfate 0.25%</i> <i>Rose water ad 30 mL</i>	
Sig: <i>For the nose.</i>	
Dispense as written	<i>Dr. Debra Lawson</i> May substitute

$$1 : 50 = 2\%$$

$$Q1 \times C1 = Q2 \times C2$$

$$X \times 2 (\%) = 30 (\text{mL}) \times 0.25 (\%)$$

$$X = 3.75 \text{ mL, answer}$$

Solve by Inverse Proportion:

$$\frac{2\%}{0.25\%} = \frac{30 \text{ mL}}{X \text{ mL}}$$

$$X = 3.75 \text{ mL, answer}$$

Calculate the Active Ingredient:

$$30 \text{ (g)} \times 0.0025 = 0.075 \text{ g of ephedrine sulfate needed}$$

1 : 50 means 1 g in 50 mL of stock solution.

$$\frac{1 \text{ g}}{0.075 \text{ g}} = \frac{50 \text{ mL}}{X \text{ mL}}$$

$$X = 3.75 \text{ mL, answer}$$

Using a Stock Vial or Ampuls

Sometimes it is necessary to make a specified concentration of a product so dosing will be easier for the patient. These are most often products that are available in vials or ampuls with concentrations in milligrams per milliliter or micrograms per milliliter. Many injectable products are mixed to physician-ordered concentrations to be given orally.

When using small volumes and low-concentration products, it is usually easier to use the same method to calculate the amount of drug (stock) and diluent as to calculate the amount of active ingredient, since these products are not labeled in percent or ratio strength, but in milligrams per milliliter or micrograms per milliliter.

Examples:

Prepare 30 mL of a 5 mg/mL oral phenobarbital solution using phenobarbital available from the manufacturer in a 65 mg/mL solution that comes in 1-mL vials. How much stock solution will be required?

$$30(\text{mL}) \times 5 \text{ mg/mL} = 150 \text{ mg required for the solution.}$$

$$\frac{65 \text{ mg}}{1 \text{ mL}} = \frac{150 \text{ mg}}{X} \quad X = 2.3 \text{ mL of phenobarbital required, answer}$$

Or

$$5 \text{ mg/mL} = 0.005 \text{ g/mL, a 0.5\% solution}$$

$$65 \text{ mg/mL} = 0.065 \text{ g/mL} = 6.5\% \text{ solution}$$

$$Q1 \times C1 = Q2 \times C2$$

$$X \times 6.5 (\%) = 30 \text{ (mL)} \times 0.5 (\%)$$

$$X = 2.3 \text{ mL of phenobarbital, answer}$$

Folic acid is available from the manufacturer in a 5 mg/mL injection. Prepare 1 oz of 25 mEq/mL oral solution. How much folic acid solution is required?

$$1 \text{ oz} = 30 \text{ mL}$$

$$30 \text{ (mL)} \times 25 \text{ mEq/mL} = 750 \text{ mEq to make the solution.}$$

$$750 \text{ mEq} = 0.75 \text{ mg}$$

$$\frac{5 \text{ mg}}{1 \text{ mL}} = \frac{0.75 \text{ mg}}{X}$$

$X = 0.15 \text{ mL}$ of folic acid, *answer*



Or

$5 \text{ mg/mL} = 0.005 \text{ g/mL}$, a 0.5% solution.

$25 \text{ mEq/mL} = 0.000025 \text{ g/mL} = 0.0025\%$ solution.

$$Q1 \times C1 = Q2 \times C2$$

$$X \times 0.5 (\%) = 30 (\text{mL}) \times 0.0025 (\%)$$

$X = 0.15 \text{ mL}$ of folic acid, *answer*

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Hydrocortisone is available in a vial of 100 mg in 2 mL. You are to prepare 24 mL of a 5-mg/mL hydrocortisone dilution using the available stock vials. How much hydrocortisone (in milliliters) and how much diluent (in milliliters) will you need?



$$\frac{X}{24 \text{ mL}} = \frac{5 \text{ mg}}{1 \text{ mL}}$$

$X = 120 \text{ mg}$ of hydrocortisone needed.

$$\frac{100 \text{ mg}}{2 \text{ mL}} = \frac{120 \text{ mg}}{X \text{ mL}}$$

$X = 2.4 \text{ mL}$ of hydrocortisone, *answer*

$24 \text{ mL} - 2.4 \text{ mL} = 21.6 \text{ mL}$ of dilute, *answer*

Or

$5 \text{ mg/mL} = 0.005 \text{ g/mL}$, a 0.5% solution

$100 \text{ mg}/2 \text{ mL} = 0.1 \text{ g}/2 \text{ mL}$, a 5% solution

$$Q1 \times C1 = Q2 \times C2$$

$$X \times 5 (\%) = 24 \text{ mL} \times 0.5 (\%)$$

$X = 2.4 \text{ mL}$ hydrocortisone, *answer*

$24 \text{ mL} - 2.4 \text{ mL} = 21.6 \text{ mL}$ diluent, *answer*

Review Set 10.1: Stock Solutions

1. If 250 mL of a 1 : 800 v/v solution is diluted to 1000 mL, what will be the ratio strength v/v?
2. Aluminum acetate topical solution contains 5% w/v aluminum acetate. When 100 mL is diluted to 1 L, what will be the ratio strength w/v?
3. If 400 mL of a 20% w/v solution is diluted to 2 L, what will be the percentage strength w/v?
4. If a 0.067% w/v methylbenzethonium chloride lotion is diluted with an equal volume of water, what will be the ratio strength w/v of the dilution?
5. How much 40% solution is needed to make 500 mL of a 5% solution?
6. How much of a 1 : 80 solution is needed to make 500 mL of a 0.02% solution?
7. How much of a 0.06% topical solution is required to make 200 mL of a 1 : 10,000 solution?
8. Folic acid is available from the manufacturer in vials of 5 mg in 1 mL. Prepare 30 mL of a folic acid dilution in a 100 mcg/mL concentration. How much folic acid (in milliliters) do you need?
9. Hydrocortisone is available in a concentration of 100 mg/2 mL from the manufacturer. You are to prepare 10 mL of a 15-mg/mL preparation. How much hydrocortisone do you need?

10. How much diluent (in milliliters) must be added to 180 mL of a 40% solution to make a 5% solution?
11. A solution of potassium permanganate is prepared by dissolving 16 tablets of 0.2 g in enough purified water to make 1600 mL.
 - a. What is the percentage strength of the solution?
 - b. What is the ratio strength of the solution?
12. Potassium iodide oral solution, USP, contains 1 g/mL of potassium iodide. How much of the solution (in milliliters) should be used to obtain the potassium iodide required in compounding the prescription below?

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Name: <u>Virginia Millhouse</u>	<u>678 Apple St.</u>
Rx:	<i>Potassium iodide (50 mg/tsp)</i>
Sig:	<i>Ephedrine sulfate 240 mL</i>
	<i>Syrup ad</i>
	<i>1 tsp as directed.</i>
<hr/>	<hr/>
Dispense as written	May substitute <i>Dr. Debra Lawson</i>

13. Clindamycin is available in a solution of 150 mg/mL. How much of this solution is required to make 15 mL of a clindamycin ophthalmic injection 1 mg/0.1 mL?
14. In preparing a solution for a wet dressing, two 0.3-g tablets of potassium permanganate are dissolved in 1 gal of purified water. What will be the percentage strength w/v of the solution?
15. If 150 mL of a 17% w/v concentrate of benzalkonium chloride is diluted to 5 gal, what will be the ratio strength w/v of the dilution?
16. What is the strength of a sodium chloride solution obtained by evaporating 800 g of a 10% w/w solution to 250 g?
17. A physician prescribes an ophthalmic suspension to contain 100 mg of cortisone acetate in 8 mL of normal saline solution. The pharmacist has on hand a 2.5% suspension of cortisone acetate in normal saline solution. How much (in milliliters) of this and how much normal saline solution (in milliliters) should be used in the prescribed suspension?

Determining Quantity of Active Ingredient in Specified Amount of Solution Given Strength of Diluted Portion

From the strength of the diluted portion, it is possible to calculate the *quantity of active ingredient* that the undiluted portion must have contained and then by proportion to calculate how much active ingredient must be present in any other amount of the stock solution.

Examples:

How much silver nitrate should be used in preparing 50 mL of a solution such that 5 mL diluted to 500 mL will yield a 1 : 1000 solution?

1 : 1000 means 1 g of silver nitrate in 1000 mL of solution

$$\frac{1000 \text{ mL}}{500 \text{ mL}} = \frac{1 \text{ g}}{X \text{ g}}$$

$X = 0.5$ g of silver nitrate in 500 mL of *diluted* solution (1 : 1000), which is *also* the amount in 5 mL of the *stronger* (stock) solution, since the 500 mL and the 5 mL are the same strength.

$$\frac{5 \text{ mL}}{50 \text{ mL}} = \frac{0.5 \text{ g}}{X \text{ g}}$$

$X = 5$ g, *answer*

How much (in milliliters) of a 17% w/v concentrate of benzalkonium chloride should be used in preparing 300 mL of a stock solution such that 15 mL diluted to 1 L will yield a 1 : 5000 solution?

1 L = 1000 mL

1 : 5000 means 1 g of benzalkonium chloride in 5000 mL of solution.

$$\frac{5000 \text{ mL}}{1000 \text{ mL}} = \frac{1 \text{ g}}{X \text{ g}}$$

$X = 0.2$ g of benzalkonium chloride in 1000 mL of *diluted* solution (1 : 5000), which is *also* the amount in 15 mL of the *stronger* (stock) solution to be prepared, because the amount of drug has not changed but simply been diluted.

$$\frac{15 \text{ mL}}{300 \text{ mL}} = \frac{0.2 \text{ g}}{X \text{ g}}$$

$X = 4$ g of benzalkonium chloride.

A 17% w/v concentrate contains 17 g/100 mL. Therefore:

$$\frac{17 \text{ g}}{4 \text{ g}} = \frac{100 \text{ mL}}{X \text{ mL}}$$

$X = 23.5$ mL, *answer*

Amount of Diluent Needed for Preparing Solution of Specified Lower Strength

When given the quantity and strength of a solution, it is possible to determine how much diluent should be added to reduce its strength as desired by first calculating the quantity of weaker solution that can be made and then subtracting from this the original quantity.

Examples:

How much water (in milliliters) should be added to 300 mL of a 1 : 750 w/v solution of benzalkonium chloride to make a 1 : 2500 w/v solution?

$$1 : 750 = 0.133\% \quad 1 : 2500 = 0.04\%$$

$$Q_1 \times C_1 = Q_2 \times C_2$$

Remember that Q_2 *always* represents the final volume and Q_1 represents the volume of the stock solution.

$$300 \text{ mL} \times 0.133 (\%) = X \times 0.04 (\%)$$

$$X = 997.5; \text{ round to } 1000 \text{ mL}$$

This is the volume of 0.04% solution. Therefore it is necessary to subtract the volume of the 0.133% solution (the original amount) from this final volume to determine how much water or diluent was added.

$$1000 \text{ mL} - 300 \text{ mL} = 700 \text{ mL, answer}$$

Solve by Inverse Proportion:

$$\frac{0.04\%}{0.133\%} = \frac{300 \text{ mL}}{X \text{ mL}}$$

$$X = 997.5; \text{ round to } 1000 \text{ mL of } 0.04\% \text{ w/v solution to be prepared}$$

The difference between the volume of *diluted* (weaker) solution prepared and the volume of *stronger* solution used is the volume of water (diluent) to be used.

$$1000 \text{ mL} - 300 \text{ mL} = 700 \text{ mL, answer}$$

Calculate the Active Ingredient:

300 mL of a 1:750 w/v solution contains 0.4 g of benzalkonium chloride.

$$\frac{1 \text{ g}}{0.4 \text{ g}} = \frac{2500 \text{ mL}}{X \text{ mL}}$$

$$X = 1000 \text{ mL}$$

$$1000 \text{ mL} - 300 \text{ mL} = 700 \text{ mL, answer}$$

How much water (in milliliters) should be added to 1 pt of a 5% w/v solution of boric acid to make a 2% w/v solution?

$$1 \text{ pt} = 473 \text{ mL}$$

$$Q_1 \times C_1 = Q_2 \times C_2$$

$$473 \text{ mL} \times 5 (\%) = X \times 2 (\%)$$

$$X = 1182.5 \text{ mL}$$

This is the final volume. Subtract to determine the amount of water or diluent that must be added.

$$1182.5 \text{ mL} - 473 \text{ mL} = 709.5 \text{ mL, answer}$$

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If the strength of the original solution is unknown but the quantity of active ingredient it contains is known, the simplest procedure is to calculate directly what must be the amount of solution of the strength desired if it contains this quantity of active ingredient. Then, subtracting the given original amount yields the required amount of diluent.

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Example:

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

1 : 5000 means 1 g in 5000 mL of solution.

$$\frac{1 \text{ g}}{0.5 \text{ g}} = \frac{5000 \text{ mL}}{X \text{ mL}}$$

$X = 2500 \text{ mL}$ of 1 : 5000 w/v solution containing 0.5 g of benzalkonium chloride.

$$2500 \text{ mL} - 375 \text{ mL} = 2125 \text{ mL, answer}$$

Dilution and Concentration of Solids

Miscellaneous Problems

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Examples:

How much opium (in grams) containing 15% w/w of morphine and how much lactose (in grams) should be used to prepare 150 g of opium containing 10% w/w of morphine?

$$Q_1 \times C_1 = Q_2 \times C_2$$

$$X \times 15 (\%) = 150 (\text{g}) \times 10 (\%)$$

$X = 100 \text{ g}$ is the weight of the 15% opium, *answer*

C2 is always the volume or weight of the *final* product. Subtract the weight of the opium from 150 g.

$$150 \text{ g} - 100 \text{ g} = 50 \text{ g of lactose, answer}$$

100 g of 15% opium and 50 g of lactose, *answers*

Solve by Inverse Proportion:

$$\frac{15\%}{10\%} = \frac{150 \text{ g}}{X}$$

$X = 100 \text{ g of 15% opium, and}$

$$150 \text{ g} - 100 \text{ g} = 50 \text{ g of lactose, answers}$$

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If some drug contains 7.2% w/w of active ingredient and 21.6% of water, what will be the percentage w/w of active ingredient after the drug is dried?

100 g of moist drug would contain 21.6 g of water and would therefore weigh 78.4 g after drying.

$$\frac{78.4 \text{ g}}{100 \text{ g}} = \frac{7.2\%}{X\%}$$

$X = 9.2\%$, *answer*

.....

How much (in grams) of 20% benzocaine ointment and how much (in grams) of ointment base (diluent) should be used in preparing 5 lb of 2.5% benzocaine ointment?
 $5 \text{ lb} = 454 \text{ g} \times 5 = 2270 \text{ g}$

$$Q1 \times C1 = Q2 \times C2$$

$$X \times 20 (\%) = 2270 (\text{g}) \times 2.5 (\%)$$

$X = 283.75$ or 284 g of 20% ointment needed

Subtract the amount of 20% ointment needed from the weight of the final product to determine the amount of ointment base (diluent) needed.

$$2270 \text{ g} - 284 \text{ g} = 1986 \text{ g of diluent needed.}$$

284 g of 20% ointment and 1986 g of diluent, *answers*

Solve by Inverse Proportion:

$$\frac{20\%}{2.5\%} = \frac{2270 \text{ g}}{X \text{ g}}$$

$X = 283.75$ or 284 g of 20% ointment, *and*

$$2270 \text{ g} - 284 \text{ g} = 1986 \text{ g of ointment base, answers}$$

Or

Calculate the Active Ingredient:

$$5 \text{ lb} = 454 \text{ g} \times 5 = 2270 \text{ g}$$

$$2270 \text{ g} \times 2.5\% = 56.75 \text{ g of benzocaine needed}$$

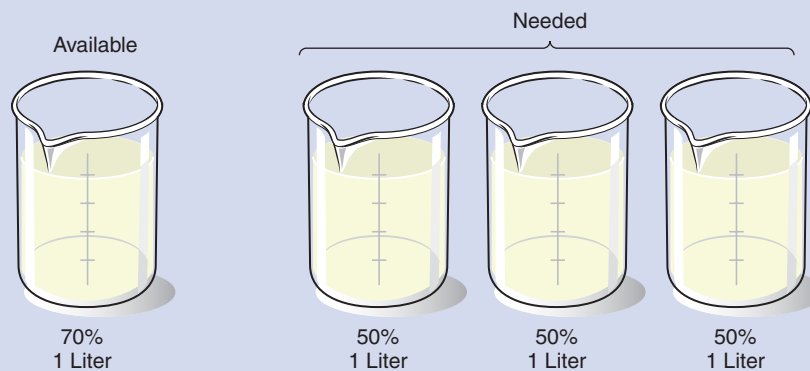
$$\frac{20 \text{ g}}{56.75 \text{ g}} = \frac{100 \text{ g}}{X \text{ g}}$$

$$X = 283.75 \text{ or } 284 \text{ g of } 20\% \text{ ointment, and}$$

$$2270 \text{ g} - 284 \text{ g} = 1986 \text{ g of ointment base, answers}$$

**Critical Thinking 10.2**

The technician was asked to prepare 3 L of 50% alcohol from 70% alcohol. There was only 1 L of 70% alcohol available. The technician calculated that only about half of the order (1400 mL) could be filled. Did the technician calculate correctly, or was there enough alcohol to fill the entire order?



For another simple method, alligation alternate, see the next section of this chapter. The alligation alternate method of problem solving can be used in many dilution concentration calculations.

Review Set 10.2: Dilution and Concentration of Solids

1. How much water (in milliliters) must be added to 250 mL of a 25% w/v stock solution of sodium chloride to prepare a 0.9% w/v sodium chloride solution?
2. How much silver nitrate (in grams) should be used in preparing 500 mL of a solution such that 10 mL diluted to 1 L will yield a 1 : 5000 solution?

3. You are to prepare 2 L of a 15% neomycin solution; you have on hand a 25% solution. How much stock and how much water do you need?
4. A pediatrician on staff at your institution has required a certain antibiotic to be mixed in white petrolatum to produce a 25% antibiotic preparation. A new pediatrician is now the chief of the department and changes the protocol to be only 12.5%. How much white petrolatum must be mixed with each 4-oz ointment jar of the 25% preparation to make the new 12.5% preparation?
5. A new protocol has been instituted for soaking certain equipment in a 10% benzalkonium solution. The old protocol was 17%. How much water do you need to prepare 2 L of the 10% solution?
6. A pharmacist added 10 g of 30% w/w calamine cream to 200 g of Aquaphor®. What is the percent strength w/w of the final calamine product?

Alligation

Alligation is an arithmetical method of solving problems that involve the mixing of ingredients possessing different percentage strengths. The student technician must remember that diluents are substances with no active ingredient and therefore are at 0%. They include such materials as lactose, sterile water, and petrolatum. Active ingredients alone are 100%.

alligation Calculation of the relative amounts of ingredients of different percentage strengths to make up a product of a given strength.

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. In other words, the procedure is to calculate the amount of active ingredient in each substance in the compound, then calculate what percent of the whole compound the active ingredient is. Of course, the quantities must be expressed in a common denomination, whether of weight or volume.

alligation medial Calculation of the mixture of ingredients possessing different percentage strengths using the weighted average of the mixture, given the quantity and concentrations.

Examples:

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.

$$0.4 \times 3000 \text{ mL} = 1200 \text{ mL, or 40\% of 3000.}$$

$$0.6 \times 1000 \text{ mL} = 600 \text{ mL, or 60\% of 1000.}$$

$$0.7 \times 1000 \text{ mL} = 700 \text{ mL, or 70\% of 1000.}$$

Totals: 5000 mL 2500 mL (total amount of alcohol)

$$2500(\text{mL}) \div 5000(\text{mL}) = 0.5 \times 100 = 50\%, \text{ answer}$$

(What percent of 5000 is 2500?)

What is the percentage of zinc oxide in an ointment prepared by mixing 200 g of 10% ointment, 50 g of 20% ointment, and 100 g of 5% ointment?

$$0.10 \times 200 \text{ g} = 20 \text{ g}$$

$$0.20 \times 50 \text{ g} = 10 \text{ g}$$

$$0.05 \times 100 \text{ g} = 5 \text{ g}$$

$$\text{Totals: } 350 \text{ g} \quad 35 \text{ g}$$

$$35(\text{g}) \div 350(\text{g}) = 0.10 \times 100 = 10\%, \text{ answer}$$

.....

In some problems the addition of a solvent or vehicle must be considered; therefore, it is necessary to add the volume of the solvent or the weight to the total. It is generally best to consider the diluent as having zero percentage strength, as in the following problem.

.....

Example:

What is the percentage v/v of alcohol in a mixture containing 500 mL of terpin hydrate elixir (40% v/v alcohol), 400 mL of theophylline sodium glycinate elixir (21% v/v alcohol), and sufficient simple syrup to make 1000 mL?

$$0.40 \times 500 \text{ mL} = 200 \text{ mL}$$

$$0.21 \times 400 \text{ mL} = 84 \text{ mL}$$

$$0 \times 100 \text{ mL} = 0 \text{ mL}$$

$$\text{Totals: } 1000 \text{ mL} \quad 284 \text{ mL}$$

$$284(\text{mL}) \div 1000(\text{mL}) = 0.284 \times 100 = 28.4\%, \text{ answer}$$

(Remember to add the volume of the 0% product.)

.....

Alligation Alternate

alligation alternate

Calculation of the percentage strength of two or more components of a given strength that are to be mixed to prepare a product of a desired strength.

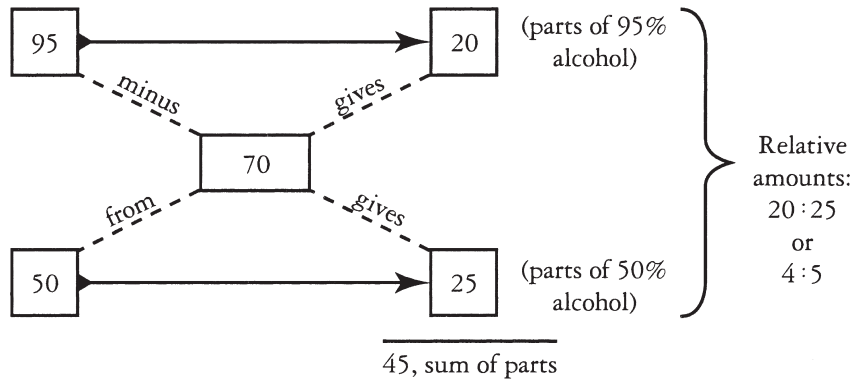
Alligation alternative is a method by which to calculate the number of parts of two or more components of a given strength when they are to be mixed to a desired strength. A final proportion permits the technician to translate relative parts to any specific denomination.

The strength of a mixture must lie somewhere between the strengths of its components; that is, the mixture must be somewhat stronger than its weakest component and somewhat weaker than its strongest. As indicated previously, the strength of the mixture is always a weighted average; that is, it lies nearer to that of its weaker or stronger components, depending on the relative amounts involved.

This weighted average can be found by means of an extremely simple scheme, as illustrated in the nearby figure.

Determining Relative Amounts of Components for Desired Mixture

Finding the relative amounts of components of different strengths for use in making a mixture of required strength entails the following.

**Example:**

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

The customary layout of *alligation alternate*, used in the subsequent examples, is a convenient simplification of the nearby figure.

Examples:

In what proportion should 20% benzocaine ointment be mixed with an ointment base to produce a 2.5% benzocaine ointment?

20%	2.5%	2.5 parts of 20% ointment
0%		17.5 parts of ointment base

Relative amounts: 2.5 : 17.5, or 1 : 7, *answer*

Check:

$$\begin{array}{r}
 20 \times 1 = 20 \\
 0 \times 7 = 0 \\
 \hline
 \text{Totals: } 8 \quad 20 \\
 20 \div 8 = 2.5\%
 \end{array}$$

A hospital pharmacist wants to use three lots of ichthammol ointment containing, respectively, 50%, 20%, and 5% of ichthammol. In what proportion should they be mixed to prepare a 10% ichthammol ointment? The two lots containing *more* (50% and 20%) than the desired percentage may be separately linked to the lot containing *less* (5%) than the desired percentage:

50%	10%	5 parts of 50% ointment
20%		5 parts of 20% ointment
5%		10 + 40 = 50 parts of 5% ointment

Relative amounts: 5 : 5 : 50, or 1 : 1 : 10, *answer*

Check:

$$\begin{array}{r}
 50 \times 1 = 20 \\
 20 \times 1 = 20 \\
 5 \times \underline{10} = \underline{50} \\
 \text{Totals: } 12 \quad \underline{120}
 \end{array}$$

$$120 \div 12 = 10\%$$

Other answers are possible, of course, for the two stronger lots may be mixed first in any proportions desired, yielding a mixture that may then be mixed with the weakest lot in a proportion giving the desired strength.

.....

In what proportions may a manufacturing pharmacist mix 20%, 15%, 5%, and 3% zinc oxide ointments to produce a 10% ointment?

Each of the weaker lots is paired with one of the stronger to give the desired strength, and they can be paired in two ways to produce two sets of correct answers.

20%	10%	7 parts of 20% ointment
15%		5 parts of 15% ointment
5%		5 parts of 5% ointment
3%		10 parts of 3% ointment

Relative amounts: 7 : 5 : 5 : 10, *answer*

Check:

$$\begin{array}{r}
 20 \times 7 = 140 \\
 15 \times 5 = 75 \\
 5 \times 5 = 25 \\
 3 \times \underline{10} = \underline{30} \\
 \text{Totals: } 27 \quad \underline{270}
 \end{array}$$

$$270 \div 27 = 10\%$$

.....

How much 50% w/v dextrose solution (in milliliters) and how much 5% w/v dextrose solution (in milliliters) 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.

$$\frac{9 \text{ parts}}{1 \text{ part}} = \frac{4500 \text{ mL}}{X \text{ mL}}$$

$X = 500$ mL of 50% solution, *and*

$$\frac{9 \text{ parts}}{8 \text{ parts}} = \frac{4500 \text{ mL}}{Y \text{ mL}}$$

$y = 4000$ mL of 5% solution, *answers*

.....

Quantity of One Component to Mix with Another to Obtain Desired Preparation Strength

Calculating the quantity of a component of given strength that should be mixed with a specified quantity of another component of given strength to make a preparation of desired strength involves the following.

Examples:

How much 2.5% hydrocortisone cream (in grams) should be mixed with 360 g of 0.25% cream to make a 1% hydrocortisone cream?

2.5%	1%	0.75 part of 2.5% cream
0.25%		1.5 parts of 0.25% cream

Relative amounts: 0.75 : 1.5, or 1 : 2

$$\frac{2 \text{ parts}}{1 \text{ part}} = \frac{360 \text{ g}}{X \text{ g}}$$

$$X = 180 \text{ g, answer}$$

How much white petrolatum (in grams) should be mixed with 250 g of 5% and 750 g of 15% sulfur ointments to prepare a 10% ointment?

$$\begin{array}{l} 5 \times 250 = 1,250 \\ 15 \times 750 = 11,250 \\ \hline \text{Totals: } 1000 \quad 12,500 \end{array}$$

$12,500 \div 1000 = 12.5\%$ of sulfur in 1000 g of a mixture of 5% and 15% ointments

12.5%	10%	10 parts of 12.5% mixture
0%		2.5 parts of white petrolatum

Relative amounts: 10 : 2.5, or 4 : 1

$$\frac{4 \text{ parts}}{1 \text{ part}} = \frac{1000 \text{ g}}{X \text{ g}}$$

$$X = 250 \text{ g, answer}$$

Check:

$$\begin{array}{l} 12.5 \times 1000 = 12,500 \\ 0 \times 250 = \underline{\quad 0} \\ \hline \text{Totals: } 1250 \quad 12,500 \end{array}$$

$$12,500 \div 1250 = 10\%$$

Amount of Active Ingredient to Increase Mixture Strength

Calculating the amount of active ingredient that must be added to increase the strength of a mixture of given quantity and strength entails the following:

Example:

How much coal tar (in grams) should be added to 3200 g of 5% coal tar ointment to prepare an ointment containing 20% coal tar?

Coal tar (active ingredient) = 100%		15 parts of 100% coal tar
100%	20%	
5%		80 parts of 5% ointment

Relative amounts: 15 : 80, or 3 : 16

$$\frac{16 \text{ parts}}{3 \text{ parts}} = \frac{3200 \text{ g}}{X \text{ g}}$$

$$X = 600 \text{ g, answer}$$

Check:

$$\begin{array}{r} 100 \times 600 = 60000 \\ 5 \times 3200 = 16000 \\ \hline \text{Totals: } 3800 \quad 76000 \\ 76,000 \div 3800 = 20\% \end{array}$$

Review Set 10.3: Alligation

1. How much water (in milliliters) should be added to 2500 mL of 83% v/v alcohol to prepare 50% v/v alcohol?
2. How much water (in milliliters) should be mixed with 1200 g of 65% w/w alcohol to make 45% w/w alcohol?
3. How much (in milliliters) of a syrup containing 85% w/v sucrose should be mixed with 150 mL of a syrup containing 60% w/v sucrose to make a syrup containing 80% w/v sucrose?
4. How much zinc oxide (in grams) should be added to 3400 g of a 10% zinc oxide ointment to prepare a product containing 15% zinc oxide?
5. Four equal amounts of belladonna extract, containing 1.15%, 1.3%, 1.35%, and 1.2% alkaloids, respectively, were mixed. What was the percentage strength of the mixture?

6. What is the percentage of alcohol in a mixture containing 1500 mL of witch hazel (14% alcohol), 2000 mL of glycerin, and 5000 mL of 50% alcohol?
7. Calculate the percentage of alcohol in the following lotion.
- | | |
|------------------------|----------------------|
| Coal tar solution | 80 mL (85% alcohol) |
| Glycerin | 160 mL |
| Alcohol | 500 mL (95% alcohol) |
| Boric acid solution ad | 1000 mL |
- Label: Medicated lotion.
8. In what proportion should 5% and 1% hydrocortisone ointments be mixed to prepare a 2.5% ointment?
9. In what proportion should a 20% zinc oxide ointment be mixed with white petrolatum (diluent) to produce a 3% zinc oxide ointment?
10. How many 0.2-g tablets of potassium permanganate should be used in compounding the prescription below?

Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name:	<u>Virginia Millhouse</u> <u>678 Apple St.</u>
Rx:	<i>Potassium permanganate q.s.</i> <i>Purified water ad 500 mL</i>
Sig:	<i>5 mL diluted to 1 L = 1:8000</i> <i>solution.</i>
<hr/>	<hr/>
Dispense as written	<i>Dr. Debra Lawson</i> May substitute

11. Prepare 1 L of an 8% dextrose solution using 5% dextrose and 10% dextrose. How much (in milliliters) of each is needed?
12. You are to prepare 500 mL of 6% dextrose. You have available sterile water for injection, 10% dextrose, and 50% dextrose. How much (in milliliters) of which products would you use?
13. How much coal tar (in grams) should be added to 1 lb of 10% coal tar ointment to prepare an ointment containing 25% coal tar?

PRACTICE PROBLEMS

1. If 2 tbs of povidone iodine solution (10% w/v) is diluted to 1 qt with purified water, what is the ratio strength of the dilution?
2. How much (in milliliters) each of a 2% w/v solution of tetracaine hydrochloride and a 1 : 1000 w/v solution of epinephrine hydrochloride should be used in preparing the following prescription?¹

Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name: <u>Virginia Millhouse</u>	<u>678 Apple St.</u>
Rx: <i>Tetracaine</i>	
<i>hydrochloride 0.75% w/v</i>	
<i>Epinephrine</i>	
<i>hydrochloride 1:4000 w/v</i>	
<i>Cocaine</i>	
<i>hydrochloride 3% w/v</i>	
<i>Sodium chloride</i>	
<i>solution ad 30 mL</i>	
Sig: <i>Use in eye as directed.</i>	
<hr style="width: 100%;"/>	<i>Dr. Debra Lawson</i>
Dispense as written	May substitute

3. How much diluent (in milliliters) would be required to make 500 mL of a 5% neomycin solution using a 25% neomycin solution?
4. How much (in milliliters) of a 1 : 50 w/v boric acid solution can be prepared from 500 mL of a 5% w/v boric acid solution?

5. Reglan® is available in a 5 mg/mL vial. You are required to prepare 15 mL of a 0.5 mg/mL solution. How much Reglan® (in milliliters) is needed?



6. You are required to prepare three doses of gentamicin 0.6 mg/2 mL. Your stock supply is gentamicin 20 mg/mL. How much gentamicin (in milliliters) is required, and how much diluent (in milliliters) is needed?
7. 10 mL of epinephrine 1 : 50,000 is needed for the operating room. Available is epinephrine 1 : 1000. How much epinephrine (in milliliters) and how much diluent (in milliliters) are needed for this preparation?
8. How much (in milliliters) of a 1 : 50 w/v stock solution of a chemical should be used to prepare 1 L of a 1 : 4000 w/v solution?
9. A certain product contains benzalkonium chloride in a concentration of 1:5000 w/v. How much (in milliliters) of a 17% solution of benzalkonium chloride should be used in preparing 4 L of the product?
10. How much (in milliliters) of a 10% stock solution of a chemical is needed to prepare 120 mL of a solution containing 10 mg of the chemical per milliliter?
11. You are to prepare 10 mL of Amikacin® 0.4 mg/0.1 mL for an ophthalmic injection. Using normal saline as your diluent, how much Amikacin® 500 mg/2 mL (in milliliters) and how much normal saline (in milliliters) will you need?
12. You are to prepare 15 mL of a 1 mg/0.1 mL clindamycin ophthalmic injection using a stock of clindamycin 150 mg/mL. How much clindamycin (in milliliters) and how much normal saline diluent (in milliliters) are needed?
13. How much water (in milliliters) should be added to 1 gal of 70% isopropyl alcohol to prepare a 30% isopropyl alcohol solution for soaking sponges?
14. How much water for injection (in milliliters) must be added to 10 L of a 50% w/v dextrose injection to reduce the concentration to 30% w/v?
15. The formula for a buffer solution contains 1.24% w/v of boric acid. How much (in milliliters) of a 5% w/v boric acid solution should be used to obtain the boric acid needed in preparing 1 L of the buffer solution?

16. How much (in milliliters) of a 5% w/v solution of menthol in alcohol should be used to obtain the amount of menthol needed in preparing the lotion below?

Dr. Donna Johns
7000 SW 1st Ave., Santa Fe, NM 54545
766-555-9097

Name: James Wilson 53 Iris Blvd.

Rx: *Menthol 0.1%*
Hexachlorophene 0.1%
Glycerin 10.0%
Alcohol 70%, to make 500 mL
Label menthol and
hexachlorophene lotion.

_____ *Dr. Donna Johns* _____
Dispense as written May substitute

17. How much 0.5% solution of gentian violet (in milliliters) should be used in preparing the prescription below?

Dr. Debra Lawson
888 NW 27th Ave., Miami, FL 98885
247-555-6613

Name: Virginia Millhouse 678 Apple St.

Rx: *Gentian violet solution 500 mL*
1:100,000

Sig: *Mouthwash.*

_____ *Dr. Debra Lawson* _____
Dispense as written May substitute

18. How much Burow's solution (containing 5% w/v of aluminum acetate) (in milliliters) should be used in preparing 2 L of a 1 : 800 w/v solution to be used as a wet dressing?
19. How much (in milliliters) of a 100 mg/mL concentrate of *Rhus toxicodendron* extract should be used in preparing the following prescription²?

Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name:	Virginia Millhouse 678 Apple St.
Rx:	<i>Rhus toxicodendron</i> <i>extract 10 µg/mL</i> <i>Sterile water</i> <i>for injection qs 100 mL</i>
Sig:	<i>As directed.</i>
_____	<i>Dr. Debra Lawson</i>
Dispense as written	May substitute

20. If a pharmacist adds 3 g of hydrocortisone to 60 g of a 5% w/w hydrocortisone cream, what is the final percentage strength of hydrocortisone in the product?
21. Available is tobramycin 40 mg/mL. How much tobramycin (in milliliters) is needed for the following preparation?

Dr. Donna Johns 7000 SW 1st Ave., Santa Fe, NM 54545 766-555-9097	
Name:	James Wilson 53 Iris Blvd.
Rx:	<i>Tobramycin 5 mg/mL 5 mL</i>
_____	<i>Dr. Donna Johns</i>
Dispense as written	May substitute

22. The formula for a mouthwash calls for 0.05% by volume of methyl salicylate. How much (in milliliters) of a 10% v/v stock solution of methyl salicylate in alcohol will be needed to prepare 1 gal of the mouthwash?
23. How much (in milliliters) of a 17% solution of benzalkonium chloride should be used in preparing the prescription below?

Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name:	<u>Virginia Millhouse</u> <u>678 Apple St.</u>
Rx:	<i>Benzalkonium chloride solution 240 mL Make a solution such that 10 mL diluted to 1 L equals a 1:5000 solution.</i>
Sig:	<i>10 mL diluted to L for external use.</i>
_____ Dispense as written	<i>Dr. Debra Lawson</i> _____ May substitute

24. How much water (in milliliters) should be added to 100 mL of a 1 : 125 w/v solution to make a solution such that 25 mL diluted to 100 mL will yield a 1 : 4000 dilution?
25. How much (in milliliters) of a 1% w/v solution of phenylmercuric nitrate may be used in preparing a 100-mL prescription requiring 1 : 50,000 w/v of phenylmercuric nitrate as a preservative?
26. If 20 mL of a 2% w/v solution is diluted with water to 8 pt, what is the ratio strength w/v of the dilution?
27. How much water (in milliliters) should be added to 1 L of 1 : 3000 w/v solution to make a 1 : 8000 w/v solution?
28. A 1 : 750 w/v solution of benzalkonium chloride diluted with purified water in a ratio of 3 parts of the benzalkonium solution and 77 parts of purified water is recommended for bladder and urethral irrigation. What is the ratio strength of benzalkonium chloride in the final dilution?
29. How much (in grams) of a 2.5% w/w benzocaine ointment can be prepared by diluting 1 lb of a 20% w/w benzocaine ointment with white petrolatum?

30. How much (in grams) of salicylic acid should be added to 75 g of a polyethylene glycol ointment to prepare an ointment containing 6% w/w of salicylic acid?
31. How much petrolatum (diluent) (in grams) should be added to 250 g of a 25% ichthammol ointment to make a 5% ointment?
32. How much 2.5% ophthalmic hydrocortisone acetate ointment (in grams) and how much ophthalmic base (diluent) (in grams) should be used in preparing the prescription below?

Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name:	<u>Virginia Millhouse</u> <u>678 Apple St.</u>
Rx:	<i>Hydrocortisone acetate</i> <i>ointment 10 g</i> <i>0.25%</i>
Sig:	<i>Apply to the eye.</i>
<hr/>	<i>Dr. Debra Lawson</i> <hr/>
Dispense as written	May substitute

33. How much zinc oxide should be added to the product to make an ointment containing 10% zinc oxide, as prescribed below?

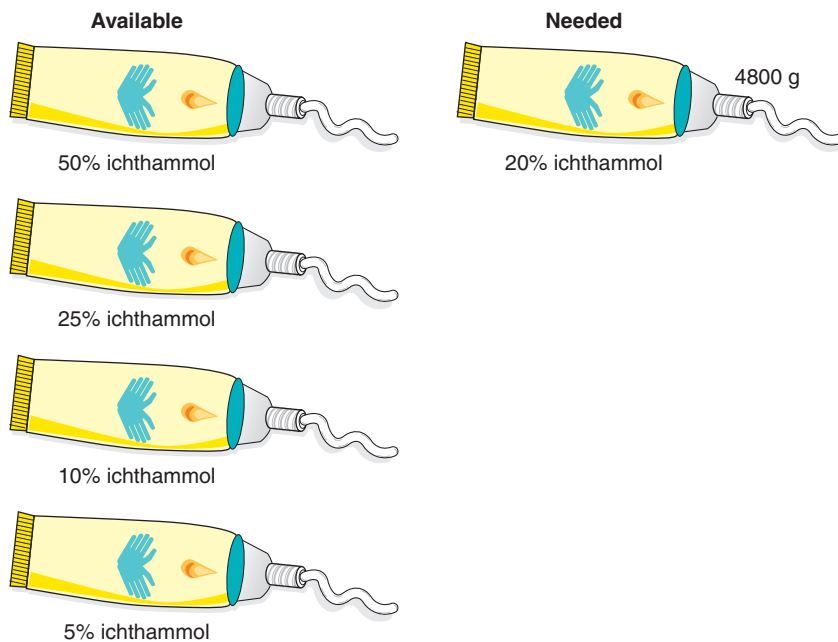
Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name:	<u>Virginia Millhouse</u> <u>678 Apple St.</u>
Rx:	<i>Zinc oxide 1.5</i> <i>Hydrophilic petrolatum 2.5</i> <i>Purified water 5</i> <i>Hydrophilic ointment ad 30</i>
Sig:	<i>Apply to affected areas.</i>
<hr/>	<i>Dr. Debra Lawson</i> <hr/>
Dispense as written	May substitute

34. In compounding the following prescription, a pharmacist added 2.5 g of coal tar to 50 g of Lassar's paste. Calculate the percentage concentration of coal tar in the finished product.

Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name: <u>Virginia Millhouse</u>	<u>678 Apple St.</u>
Rx: <i>Coal Tar 5%</i>	
<i>Lassar's paste ad 50</i>	
Sig: <i>Apply as directed.</i>	
_____	<i>Dr. Debra Lawson</i>
Dispense as written	May substitute

35. A vaginal douche powder concentrate contains 2% w/w active ingredient. What would be the percentage concentration w/v of the resultant solution after a 5-g packet of powder is dissolved in enough water to make 1 qt of solution?
36. How much (in milliliters) of a 10% w/v stock solution of a chemical should be used in preparing 120 mL of a prescription, so that a 1 : 2500 w/v solution results when the patient adds 2 tbs of the medication to 1 pt of water?
37. A pharmacist mixes 200 g of 10% ichthammol ointment, 450 g of 5% ichthammol ointment, and 1000 g of petrolatum (diluent). What is the percentage of ichthammol in the finished product?
38. A prescription calls for 0.005 g of morphine sulfate. How much (in milligrams) of a 1 : 10 trituration should be used to obtain the morphine sulfate?
39. Prepare 1 L of 7.5% dextrose using 20% dextrose and sterile water. How much of each will be needed?
40. A drug is commercially available in capsules, each containing 12.5 mg of drug and 37.5 mg of diluent. How much additional diluent (in milligrams) must be added to the contents of one capsule to make a dilution containing 0.5 mg of drug in each 100 mg of powder?
41. A hospital pharmacist reconstitutes a vial containing 2 g of piperacillin sodium to 10 mL with sterile water for injection. This solution is then diluted by adding 100 mL of 5% dextrose injection for administration by infusion. What is the concentration (in milligrams per milliliter) of piperacillin sodium in the infusion solution?
42. Calculate the percentage of alcohol in a lotion containing 2 L of witch hazel (14% alcohol), 1 L of alcohol (95%), and enough boric acid solution to make 5 L.
43. In what proportion should 95% alcohol be mixed with 30% alcohol to make 70% alcohol?

44. In what proportion should 30% and 1.5% hydrogen peroxide solutions be mixed to prepare a 3% hydrogen peroxide solution?
45. The solvent for the extraction of a vegetable drug is 70% alcohol. In what proportion may 95%, 60%, and 50% alcohol be mixed to prepare a solvent of the desired concentration?
46. What is the percentage of iodine in a mixture of 3 L of a 7% w/v iodine topical solution, 10 pt of a 2% w/v solution, and 2270 mL of a 3.5% w/v solution?
47. A manufacturing pharmacist has four lots of ichthammol ointment containing 50%, 25%, 10%, and 5% ichthammol. How much (in grams) of each may be used to prepare 4800 g of a 20% ichthammol ointment?



48. How much 2.5% w/v chlorpromazine hydrochloride injection (in milliliters) and how much 0.9% w/v sodium chloride injection (in milliliters) should be used to prepare 500 mL of a 0.3% w/v chlorpromazine hydrochloride injection?
49. How much (in milliliters) of a 2% w/v solution of lidocaine hydrochloride should be used in preparing 500 mL of a solution containing 4 mg of lidocaine hydrochloride per milliliter of solution?
50. Dopamine hydrochloride injection is available in 5-mL ampuls containing 40 mg of dopamine hydrochloride per milliliter. The injection must be diluted before administration. If a physician wishes to use sodium chloride injection as the diluent and wants a dilution containing 0.04% w/v of dopamine hydrochloride, how much sodium chloride injection (in milliliters) should be added to 5 mL of the injection?
51. A solution of benzalkonium chloride is available in a concentration of 1 : 750 w/v. How much purified water (in milliliters) should be added to 30 mL of the solution to prepare a 1 : 5000 benzalkonium chloride solution for use as a wet dressing to the skin?

52. If an antibiotic injection contains 5% w/v of the drug, how much diluent (in milliliters) should be added to 5 mL of the injection to prepare a concentration of 5 mg per milliliter?
53. A vial of cefazolin injection contains 1 g in 3 mL. If 1.6 mL of the injection is diluted to 200 mL with sodium chloride injection and if the daily dose is 25 mg/kg of body weight, how much of the dilution (in milliliters) should be administered daily to a child weighing 40 lb?
54. How much sterile water for injection (in milliliters) should be added to a vial containing 5 µg/mL of a drug to prepare a solution containing 1.5 µg/mL of the drug?³
55. How much Zephiran® chloride solution (in milliliters) should be used in preparing the prescription below?

Dr. Debra Lawson 888 NW 27th Ave., Miami, FL 98885 247-555-6613	
Name: <u>Virginia Millhouse</u>	<u>678 Apple St.</u>
Rx:	<i>Zephiran® chloride solution (17% w/v) q.s. Purified water to make 480 mL</i>
Sig:	<i>1 tbs diluted to 1 gal with water to make a 1:10,000 dilution.</i>
_____	<u>Dr. Debra Lawson</u>
Dispense as written	May substitute

56. You have on hand 800 g of a 5% coal tar ointment and 1200 g of a 10% coal tar ointment.
- If the two ointments are mixed, what is the concentration of coal tar in the finished product?
 - How much coal tar (in grams) should be added to the product to obtain an ointment containing 15% coal tar?

References

- Prince SJ. Calculations. *International Journal of Pharmaceutical Compounding* 2000;4:221.
- Karolchyk S. Treating patients allergic to poison ivy. *International Journal of Pharmaceutical Compounding* 1998;2:421.
- Prince SJ. Calculations. *International Journal of Pharmaceutical Compounding* 1999;3:145.